ANNUAL REPORT - 1949

25TH ANNIVERSARY

U.S. DEPARTMENT of AGRICULTURE • FOREST SERVICE

PACIFIC NORTHWEST FOREST AND RANGE EXPERIMENT STATION

J. A. HALL, DIRECTOR

PORTLAND, OREGON APRIL 1950

CONTENTS

ANNUAL REPORT OF THE PACIFIC NORTHWEST FOREST AND RANGE EXPERIMENT STATION FOR THE CALENDAR YEAR 1949

INTRODUCTION

July 1, 1949, marked the twenty-fifth anniversary of the establishment of the Pacific Northwest Forest and Range Experiment Station. If an institution such as this could be conceived of as possessing a single personality it would be interesting to review its reactions in looking over 25 years of varied activity and service.

Research in the Pacific Northwest did not begin in 1924. It had been in progress in silviculture since about 1909 and in range management since 1907. Early establishment of growth and yield plots over 40 years ago made possible the current obtaining of data that cover almost half a rotation in Douglas-fir, and are invaluable in determining the basic factors of the growth and yield capacity of forest land. Similarly, the earliest work in range management in this region carried out by A. W. Sampson and J. T. Jardine still gives excellent background for the current work being carried out by more advanced methods.

Looking back 25 years, the forests of the region were still being operated for the most part on a basis of straight exploitation, with the attendant production of much of the deforested land that is still being carried within the region at a dead loss. Utilization facilities were large and efficient by the standards of that day; by present standards they were crude and extremely wasteful. It was the day of the "Jap square" and the time of very low stumpage and very low margins of operating profits. Cutting practices generally were dictated by the necessity of heavy investments in railroad transportation and huge steam skidders. The advent of tractor and truck logging was not to be seen for another 10 years or so. Men, generally, could see little future in sustained-yield forest management, nor had the technical basis for such management been laid.

Today, after a quarter century of steady progress, there are many indications that the astonishing developments in forestry and utilization of recent years are but harbingers of far greater developments yet to come. There is no question any longer in most minds as to the validity of sustained-yield forest management over most of the privately owned timberlands in the Pacific Northwest. Rapid progress is being made in the adjustment of forest ownerships into units capable of long-time management. Similarly, magnificent developments in the field of integrated utilization give every indication that the day of the trash burner is numbered. It is no longer a mark of distinction to

have "the largest trash burner in the world." It is considered a mark of inefficient operation to have a trash burner at all.

In old growth, wide clear cutting and broadcast slash burning are giving way generally to the conception of small-area clear cutting, with due regard to natural seeding possibilities and proper planning of slash burning to insure optimum regeneration. The necessities of second-growth management are bringing about the development of methods of partial cutting that give every promise of greatly increased yields, both in quantity and quality, from a large proportion of forest lands.

In the pine region, the period has seen the development of advanced methods of mortality risk selection cutting that are steadily reducing insect losses, improving stands, and increasing productivity in the ponderosa pine country. There is reasonable assurance that permanent planned forestry is possible without the heavy risk of insect losses that formerly characterized the unmanaged ponderosa stands.

At the present time, the station's program is placing heavy emphasis on the working out of practical methods of cutting, both in pine and fir—methods that are silviculturally desirable and economically possible.

With full recognition that forecasting is a hazardous business, it does not seem beyond the range of real probability to predict that: (1) Much more intensive methods will be required and developed for conversion of old-growth stands and management of second-growth stands both in pine and fir; (2) utilization will continue to become more intensive, with major developments in the next few years in the fields of expanded production of fiber products and chemical goods; (3) the great progress in fire protection that has been made in 25 years on a basis of real technical findings will be intensified and tightened up by four factors: (a) much better weather prediction, especially with respect to local variations, effect of topography, and other local factors; (b) really strong information on fire behavior; (c) greater development of mechanized and improved methods of fire control; (d) more rigid planning of slash burning, with a view to silvicultural significance as well as abatement of hazard.

In the field of range research there was an interlude of practically no effort from 1914 to 1936. The work in this field was greatly expanded in 1946 and is now proceeding at a rate more nearly commensurate with its importance. Primary emphasis is in two fields—reseeding and management—and promising progress has been made in both fields.

Realization on the part of the public of the growing importance of problems of watershed management has intensified efforts in these aspects of both forest and range management. Recognition of these problems eventuated in the past year in the establishment of a Flood Control Survey unit at this station. This unit, in cooperation with similar

units at the Northern Rocky Mountain Experiment Station, the Intermountain Experiment Station, and the California Experiment Station, will complete a survey of the Columbia Basin in the next three years. In a way, the report that will emerge at that time will constitute as good an analysis of the problems in upstream land management in the Columbia Basin as could be prepared within the time available. If, again, a prediction may be hazarded, future years will include studies in watershed management to a far greater degree than has been the case in past programs.

A major accomplishment of this station, beginning in 1930, was the forest survey. This program gave, for the first time, accurate understanding of the amount, condition, and trend of the forests of the Pacific Northwest. After the completion of the initial survey, the data have been maintained continuously, and a reinventory of the region is now planned on about a 10-year cycle. The facts available from this source have been of tremendous value to public and private agencies dealing with the forest resource. It is anticipated that activity in this field will be considerably enhanced in the near future under recent increased authorizations.

Among the greatest of contributions from the Pacific Northwest Forest and Range Experiment Station over the past 25 years should be mentioned in prominent position the training of professional foresters. A great many men have at some time or other in their careers been associated with this station in some capacity. That they have benefited by that association, even though it may have been brief, cannot be doubted, and that forestry has benefited as a result is certain. There is here appended a partial list of well-known foresters who have at some time or other been connected with this station over the past 25 years. It can be only a partial list. There are many others who passed through.

Anderson, Eric A.
Andrews, Horace J.
Barrett, L. I.
Brandstrom, Axel J. F.
Briegleb, Philip A.
Byram, Geo. M.
Carlson, Roy C.
Chapman, Roy
Coile, Theodore
Coulter, Harry
Cowlin, Robert W.
Cummings, L. J.
DeVries, Wade
Dunford, Earl G.
Fowells, Harry
Girard, James W.
Gisborne, Harry T.
Griffee, W. E.
Hawley, Norman
Hayward, Frank, Jr.
Hodgman, A. W.
Hodgson, Allen H.
Hofmann, J. V.
Hopkins, Howard
Isaac, Leo A.
Johnson, Herman M.
Kearns, Richard S.
Kemp, Paul D.
Kienholz, Raymond
Kirkland, Burt P.
Kline, C. W.
Kolbe, Ernest L.
Kraebel, C. J.
Lauridsen, Morton J.
Lodewick, J. Elton
Marshall, Robert
Matthews, Donald N.
McArdle, Richard E.
Meagher, George S.
Meyer, Walter H.
Moravets, F. L.
Morris, William G.
Mowat, Edward L.
Munger, Thornton T.
Obye, Herschel
Payne, Burnett H.
Pickford, Gerald D.
Price, Wm. H.
Ramsey, Guy
Rapraeger, E. F.
Rasmussen, Boyd L.
Reid, Elbert H.
Richen, Clarence W.
Robertson, J. C. H.
Shepard, Harold B.
Simpson, A. Gail
Sims, Ivan H.
Snow, A. G.
Tillotson, C. R.
Van Meter, Tom
Wakeman, Wm. J.
Westveld, R. H.
Willis, C. P.
Willison, C. Herbert
Wilson, Sinclair A.
Wright, Ernest

FOREST ECONOMICS

Forest Survey

Conversion to the continuous inventory system and adoption of the specifications of the newly issued national Forest Survey Manual for the year's field season were the highlights of 1949. These factors were chiefly responsible for a substantial reduction in the rate of progress as compared to 1948. Other limiting factors were an unusually wet and late spring and increased travel costs. A total of approximately 2 million acres was covered by field inventory during 1949. Roughly one-third of this acreage was in Oregon and two-thirds in Washington. Coos County, Oregon, and Clark and Wahkiakum Counties, Washington, were completed and parts of Cowlitz, Grays Harbor, and Pacific Counties, Washington, were done.

Coos County completes the field work in the southwestern Oregon unit—an important new timber production area. Office compilation of type areas, timber volumes, and growth is complete for all counties in the unit except Coos. When compilation of field data for Coos County is completed statistical releases will be made for the entire unit.

Projection of types from aerial photos to base maps was completed for Douglas and Coos Counties and commenced for Clark County. One-inch-to-the-mile detailed type maps were drafted and published for Curry, Douglas, and Josephine Counties and drafting was commenced on the map for Coos County.

Office compilation of type areas and timber volumes was completed for Josephine, Curry, and Douglas Counties and commenced for Coos County.

Determination of growth and mortality was completed for Lake, Jackson, Josephine, Curry, and Douglas Counties. In preparation for this work, analysis was made of various alternative methods of growth calculation.

Next field season it is planned to complete the field inventory of Cowlitz, Pacific, and Grays Harbor Counties and commence work in Skamania County, Washington, and Columbia County, Oregon.

A new forest type classification was developed in cooperation with the regional office Division of Timber Management and published. It standardizes type definitions and simplifies the symbols used to show type, stand-size class, stocking, and condition class of forest stands. It is being used by the Forest Survey and regional office in timber surveys. Other public and private agencies plan on adopting this classification.

Preliminary results of photo mensuration studies begun this year are encouraging. Preliminary photo volume tables for young-growth Douglas-fir have been tested and are now being modified on the basis of data collected on regular inventory field plots for the past season. Tentative correlations between photo and field volume estimates are good enough to forecast appreciable reductions in field costs through a system of double sampling. If further analysis supports the first tests our intensity of field sampling will be reduced, a sample of photo plots will be substituted for that portion of the inventory, and a reduction in total inventory costs obtained. Next year the photo mensuration studies will be continued with increasing emphasis upon other species and other age classes.

The Division of Forest Economics cooperated this year on two short courses in photo interpretation for foresters. The first, sponsored jointly by Oregon State College and the station, was held at the Oregon State College Forest School and ran for six days, March 21-26. Five out of the 25 students attending were from Federal and State agencies. The remainder were industrial foresters. The course is scheduled to be repeated next year to accommodate those who could not be included this year. The second course, organized by Wilson at the request of the Region 1 office of the Forest Service, was given at Missoula, Montana, December 12-16. Assistance in instruction was provided by personnel of Region 1 and the Northern Rocky Mountain Forest and Range Experiment Station. Most of the 30 students were from national forests in Region 1; two were members of the faculty at Montana State University Forest School.

The Division of Forest Economics also cooperated with the Division of Forest Management Research and with the regional office on a Statistical Study of Sampling Methods for Cruising Timber on Small Areas. The study involved a 100-percent cruise of a 40-acre tract of old-growth Douglas-fir timber on the Blue River Experimental Forest in the Willamette National Forest. One analysis of the cruise data has indicated that the most efficient size and shape of plot to use for intensive cruise work in old-growth Douglas-fir timber is a 1-chain by 3-chain (3/10-acre) rectangular plot. This conclusion was reached after 12 different kinds of plots were tested. In general, rectangular plots were more efficient than circular plots and moderately large plots (2/10- to 3/10-acre) were more efficient than either larger plots (4/10-acre) or smaller plots (1/20- to 1/10-acre). The circular 1/4-acre plot was more efficient than all other circular plots tested.

Forest drain as a result of production of sawlogs, pulpwood, poles and piling, and other minor products was determined for 1948 by means of a mail and field canvass of producers in Oregon and Washington. Total log production as determined by the Survey was approximately 11.8 billion board feet, log scale.

A cooperative canvass of 1948 lumber production in Oregon and Washington was conducted with the West Coast Lumbermen's Association and

the Western Pine Association. Also, the Division acted as an intermediary between the Western Pine Association and the California and Northern Rocky Mountain Stations and Regions 2, 3, and 4 in the canvass of lumber production in the other western States. In Oregon and Washington production data were obtained by a 100-percent mail canvass of all known sawmills, a field follow-up of all nonrespondents with an annual production of 5 million feet or more, and a "blow-up" of smaller nonrespondents based on a randomly selected sample. More than 98.5 percent of the total production in the two States was obtained from actual reports--mail or field follow-up. Total production for Oregon was 7,842 million board feet, which is the all-time record for a single State. Washington, with 7,586 million feet, formerly had that distinction. In 1948 Washington produced 3,660 million feet, which is less than it produced in 1907.

Financial Aspects

Lumber grade recovery studies. During the year a lumber grade recovery study was made on second-growth ponderosa pine. This is part of a thinning study being carried on at the Pringle Falls Experimental Forest.

The station assisted the Oregon Forest Products Laboratory with their lumber grade recovery study in cooperation with the Valsetz Lumber Company. The primary purpose of this study was to obtain lumber recovery data on defective logs as a part of the comprehensive decay study started two years ago.

Assistance was also given Harbor Plywood Company in a veneer grade recovery study. Information was needed on the relative value of the same grade of peeler logs from southern Oregon as compared with those from southwestern Washington. Approximately 45 thousand board feet of logs of the three peeler grades for each area were put through the lathe and the veneer graded and tallied. Grade for grade, the logs from Washington produced a higher percentage of the better veneers than those from Oregon.

During the coming year it is planned to continue with the lumber grade recovery studies for the various producing areas in the Douglas-fir region. Some studies of this type have been made, but much additional information is needed. The Coos Bay area and the Medford area are the proposed locations for the next two studies.

FOREST UTILIZATION SERVICE

Activities in the Forest Utilization Service during the year continued to focus the attention of research agencies to problems in forest products and toward developing industrial application of results obtained in the laboratory. Prominent in the list of research objectives were:

1. Evaluation of suitability of molasses produced from "wood waste" when used as a high concentrate carbohydrate stock feed.

2. Production of synthetic boards from various types of wood fiber waste.

3. Improvements in timber harvesting.

4. Improvement in predicting peeler and sawmill log quality.

5. Improved utilization of sawmill slabs, edgings, and trim.

6. Development of economical pulping methods for little-used wood species.

7. Improved use of common grades of lumber in producing laminated structural wood members.

8. Development of low-cost lumber dry kiln equipment.

9. Evaluation of strength and other physical properties of lumber and timbers cut from second-growth Douglas-fir and ponderosa pine.

10. Utilization of wood sawdust as mulch and soil conditioner.

A review of technical developments during the year and practices in industry demonstrates that the results of laboratory research promote a better utilization of our timber crop as a source of raw material.

Reduction and Recovery of "Logging Waste"

While salvage logging operations were greatly stimulated during the war period in response to the high demand for wood products, it is interesting to note that this type of timber harvesting continues in the post-emergency period. Temporary weakening of the log and lumber market during the past summer was reflected in decreased salvage logging activities. Following recently improved markets, observations show that in the Portland area, where pulp mill operations provide an outlet for logs too small or otherwise unsuited for sawmills, those companies which were practicing extensive salvage logging a few years ago are continuing the practice to a comparable extent. Areas which are currently being cleaned up on a salvage logging basis appear as clean as were similar operations two years ago.

The prospects for increased interest in the economics of salvage logging may be stimulated by recent results obtained in one of the station's experimental forest areas (Puget Sound) where a thinning project is under way. Preliminary results show that the cost of thinning plus 40 miles transportation was $12 per cord, with no allowance for

stumpage. This cost is well within reach of the current value of wood material in the pulpwood market.

Log Grade Studies

The Douglas-fir plywood industry uses the best available grades of logs for the production of veneer. The ability of a log to qualify as a "peeler" is based on its ability to produce veneer suitable for plywood faces. Knots and pitch pockets are the principal defects which lower the veneer grade below face quality.

The plywood industry in this area has been developed mostly on the basis of using relatively large Douglas-fir logs because large old-growth trees generally contain a relatively deep, clear zone of wood. However, with the expansion of the industry and the decreasing supply of large old-growth timber, the industry is forced to turn to lower grade and smaller logs. In establishing the value of such logs it is increasingly important to evaluate accurately the amount of face quality veneer which can be obtained from them. Experience has shown, however, that it is not possible with the present state of knowledge of Douglas-fir logs to determine how deep a zone, clear of undesirable knots, is to be found in individual logs. Consequently, logs are often graded higher or lower than is warranted by the veneer they produce. Further, many peeler type logs are found to contain a large number of pitch pockets, especially in the outer zone free of knots. These pitch pockets lower the quality of veneer, requiring either patching to raise the veneer to a face grade or dropping to a lower grade when the pockets are too large or numerous to lend themselves to patching. It would be a distinct advantage if it were possible by some means of inspection to predict more accurately the occurrence of knots and pitch pockets in logs selected for the production of plywood.

The Forest Products Laboratory at Madison, Wis., has for a number of years studied the quality of wood in hardwood logs in the southern and eastern parts of the country and has been able to improve the prediction of growth defects inside the log by making a more careful examination and developing a better understanding of the external appearance of the log and the presence of defect indicators. The result of these studies has been to sharpen the ability of lumbermen to grade and allocate logs in accordance with the products to be made from them.

During 1949 the Laboratory started a project on Douglas-fir logs, seeking to develop a better correlation between the external appearance of peeler logs and the quality of veneer produced from them, using as a background the benefits obtained in the studies on hardwood logs. Preliminary studies were conducted at two plywood plants—one in the southwest part of Oregon and one in the Puget Sound area.

In making these studies data on the site, exposure, stocking, etc. of the timber stand prior to logging were obtained. This information

will be correlated with that obtained at the plywood mill, where the logs were diagrammed for defects and defect indicators and the development of defects was studied as the logs were cut into veneer at the lathe. It is planned that this study will be continued into the coming year.

Reduction in Waste in Sawmills

Production of cut stock from slabs, edgings, and other "sawmill waste" in the Douglas-fir region declined during the year from the levels established during the war period, largely due to marketing problems. The use of cut stock products during the war period, however, established its acceptability by the customer and it is anticipated that its production will expand as marketing problems are ironed out.

Another expanding use for Douglas-fir sawmill waste is in the form of chips for the pulpwood and hardboard industry. Heretofore Douglas-fir has been used to a limited extent only for pulp production, but the operation of the newly constructed kraft pulp mills and of board plants in the Pacific Northwest is changing the picture. Some sawmills which fully remove the bark from waste wood find a profitable outlet for such waste fiber when it is properly chipped. These sawmills find a further advantage due to their ability to handle the slabs and edgings more economically than when they are sent to a pulp mill for chipping.

The high percentage of wood fiber in a log which in one way or another becomes waste in the sawmill in the manufacture of finished lumber is illustrated again in a study made at Lakeview where a sawmill cutting pine lumber, kiln drying and planing it before shipment, was studied. About 20 percent of the lumber output is remanufactured into cut stock and box shook. The finished lumber, cut stock, and shook products shipped from the mill constituted only 45 percent of the wood fiber in the sawlogs entering the mill. The remaining 55 percent was lost in the form of sawdust (19 percent), slabs and edgings (25 percent), and shavings and trim (11 percent), all of which were used for fuel or were burned as waste. This plant is a typical modern mill operation and serves as a reminder of the relatively large resource in unused wood fiber in a large segment of the industry.

Seasoning of Lumber

The seasoning of lumber continues to be an asset and also a problem for the lumber producers of the Pacific Northwest. During 1949 a considerable amount of additional capacity in conventional steam-heated dry kilns was built but not much progress was made in the development of a low-cost kiln for the small sawmill operator. Practically all of the new installations in the Douglas-fir region were relatively large compartment-type kilns for drying green lumber. In the pine region there is some development toward a low-capital-cost kiln fired with oil or coal and intended particularly for serving the small mill. These new installations have not yet had time to demonstrate their usefulness as a drying tool in the industry.

Another seasoning development in the pine area combines air drying with kiln drying by sticking the green lumber in unit packages which can be handled by fork-lift trucks. Some mills are placing such stuck units of green lumber on the air drying yard to accomplish partial seasoning and then by use of the lift trucks move the air dried unit packages to the dry kiln to complete the seasoning, thus eliminating rehandling and resticking of the lumber into dry kilns. These mills find a substantial advantage in this practice, through a reduction in the amount of steam required to operate the kilns per M board feet of lumber dried. Green pine lumber contains a good deal of water and the green mill waste which is used for fuel has less ability to generate steam than the green waste of Douglas-fir mills with a much lower original moisture content.

Although various agencies interested in the seasoning of lumber continue to seek cheaper methods for the process, none were developed and made public during the year which are directly applicable to seasoning softwoods of the Pacific Northwest.

Efforts to induce seasoning of a larger volume of the lumber output are directed toward a wider understanding of the techniques already known for drying lumber and the installation of additional dry kiln capacity. One fruitful channel for accomplishing this objective is through cooperation with the several dry kiln clubs in the region. The membership of these clubs is recruited principally from the operators of dry kiln batteries. There have been three such clubs in this region and an additional one was formed during the year in eastern Oregon. The Forest Utilization Service assists these clubs in developing their programs and in extending information on the seasoning of lumber in connection with the regular meetings.

A demonstration and instructional course on the kiln drying of lumber was sponsored by the Oregon Forest Products Laboratory at Corvallis, Oreg., and was attended by twenty-eight persons, all from the State of Oregon but representing both the Douglas-fir and pine regions. The Forest Service cooperated by furnishing an instructor from the Forest Products Laboratory at Madison, Wis., and one from the Forest Utilization Service unit. This method of accomplishing a better and more widely understood practice of seasoning lumber is so effective that additional efforts in this direction are contemplated in both Oregon and Washington for the coming year.

Changes in the lumber market during the past year gave more marketing emphasis to the advantages of kiln drying of all grades of lumber. The consuming public continues to demand that clear grades of lumber always be thoroughly dried. In periods of weaker markets, seasoned common grades sell more easily than unseasoned items. It is to be expected, therefore, that in the coming year customers will continue in this frame of mind and that kiln drying facilities and operations will continue to expand.

One of the auxiliary problems in the seasoning of ponderosa and sugar pine lumber is the development of a chemical brown stain. The causes for and the means of avoiding such stains in the process of drying green pine lumber are not thoroughly understood and this problem is currently a subject of study by the Forest Products Laboratory. Only initial phases of the study could be undertaken in 1949 and it is expected that the study will be continued into the coming year. There is some evidence that chemical stains also develop during the process of seasoning hemlock and Sitka spruce, although the known extent of such damage has been very minor. It is quite possible that the solution to the problem in pine may find an application to other softwood species.

Glued and Laminated Products

An important progressive step in the use of glued laminated structural wood members was made during the year through the announcement of new strength values by the Forest Products Laboratory. These values were based on strength tests on full-sized beams of commercial quality made in a cooperative study between the Laboratory, the National Lumber Manufacturers Association, and industry. The commercial production of glued laminated wood structural members must be directed largely toward the use of common grades of softwood lumber if this type of material is to develop into an economic and widely used product. The Laboratory's findings on the effect of knots and other growth characteristics on the strength of wood, and their importance as related to their size and position in the glued beam pave the way for the structural engineer to use selected high strength laminations where high strength is needed and to use lower quality laminations where strength requirements are less important. It is anticipated that continued research in this field will permit the generation of structural grades of glued laminated wood products in the Pacific Northwest leading to a production and marketing practice similar to that which has been developed in the lumber industry.

Lumber From Second-Growth Timber Stands

The projects of Forest Management Research which study the development of new crops of timber lead to the need for studies on the physical properties of the wood obtained from timber stands grown under management plans. The practice of cutting lumber from second-growth stands, especially during the war period, hastened the need for determining the physical properties of the lumber produced and marketed from them. Several years ago this station assisted the Forest Products Laboratory in selecting sample logs in second-growth Douglas-fir stands which were then shipped to Madison for study. From test results the Laboratory established that the strength properties of the wood relate themselves to those of old-growth Douglas-fir in accordance with their specific gravity relationships. This is an important finding for this region in that it will enable the quick establishment of the physical properties of wood produced under various management plans.

During the past year a similar approach has been begun on the properties to be expected in second-growth ponderosa pine. Again this station cooperated with the Forest Products Laboratory in the selection of sample logs from second-growth ponderosa pine in this region, securing samples from the several sites in which second-growth ponderosa pine is found. Most of the test material was obtained in the Pringle Falls Experimental Forest area.

A similar plan of approach to the problem on second-growth stands of Port Orford cedar has been initiated and this study is being undertaken by the Oregon Forest Products Laboratory of Corvallis, following generally the plan used by the Forest Products Laboratory at Madison on the second-growth problem.

Pulp and Paper

During the year this area has seen an expansion in the use of lodgepole for the production of kraft pulp, it being blended with pulp made from old-growth Douglas-fir. The St. Helens Pulp and Paper Company has increased its holdings of lodgepole pine timber stands on the east side of the Cascade Range and has used increased amounts in its kraft mill at St. Helens. A cost of $10 per cord for lodgepole loaded on cars in the timber area combined with a freight charge of $6 per cord for shipment to St. Helens enables it to utilize this type of raw material economically.

Red alder also received attention for potential use as a source of raw material for pulp. The Forest Products Laboratory has on its current program a project for studying the suitability of red alder for semichemical and kraft pulping and arrangements are currently under way to assist the Laboratory in securing red alder samples from the Pacific Northwest for pulping studies. A number of pulp companies have expressed interest in this development.

Wood Hydrolysis

Within the past few months the alcohol plant at Springfield, Oreg., has been leased to the newly formed Oregon Wood Chemical Company, which is undertaking a different operating plan. Instead of producing the end product for which this plant was built (industrial alcohol) it is proposed that wood molasses be made for stock and poultry feed. For the first six months to a year only one percolator will be modified and rehabilitated. It will be operated in conjunction with evaporators as a semicommercial molasses plant. If this semicommercial plant is operated at full capacity, the production would amount to about 50 tons of molasses per day. During this period the optimum operating conditions and economics will be determined. The ultimate plan of this company is to rehabilitate the other four percolators after the experimental work has been completed. If the first percolator operates satisfactorily, as is expected, development work will be started on a pilot-plant scale to produce yeast for

stock and poultry feed. The part of the plant required for fermentation and distillation of alcohol will be held in stand-by condition so that the plant can be switched in a minimum length of time to this product if and when the occasion arises.

Experiments in feeding molasses and yeast derived from the hydrolysis of Douglas-fir sawmill waste have progressed to the point where important results are being established. Molasses has been fed satisfactorily to sheep, beef and dairy cattle, swine, and poultry and has been used as a preservative for grass silage. Much work yet remains to be done to properly evaluate wood molasses as a stock and poultry feed. The preliminary results have been most encouraging.

Recently sufficient yeast was made available to the Dairy Husbandry Department at Washington State College to determine its value as a protein supplement and a source of unidentified vitamins required for egg production, hatchability, and chick growth. These preliminary tests were very satisfactory. The yeast which was used in the test was comparable to fish meal. Because of its vitamin content Torula yeast may be important in starter rations for dairy calves and in swine feeding. Fundamental nutritional studies have been started to determine the value of various strains of yeast produced on wood-sugar solutions.

Feeding tests of equal importance are being conducted at Oregon State College, sponsored by the Oregon Forest Products Laboratory. Included in these tests are the feeding of dairy cattle with grass silage to which has been added wood molasses, the feeding of wood molasses to spring pigs while they are on pasture, the feeding of wood molasses to lambs which are being fattened, and the feeding of wood molasses to laying hens over a 2-year period. Preliminary results at this college indicate all-around favorable reaction from the use of molasses as a carbohydrate constituent of the feeding ration.

Cooperation

Among the channels through which the Forest Utilization Service has an opportunity to function is cooperation with the various Federal, State, and private research agencies interested in the utilization of wood. Cooperation results in bringing together efforts for carrying on research and for disseminating the results of research into channels where they can be applied to commercial problems and production.

During the year the Forest Utilization Service enjoyed excellent cooperation with agencies in this region such as the Oregon Forest Products Laboratory, Oregon State College, the University of Washington, Washington State College, the Institute of Forest Products of the State of Washington, the Pacific Northwest Wood Products Clinic, the Forest Products Research Society, and the local dry kiln clubs.

RANGE RESEARCH

From the standpoint of the range research program in the Northwest, 1949 was a good year. Most of the present program, which was begun in 1945, was now reaching an age where significant results were beginning to appear. The research team was rounded out with the transfer of Clark Holscher from the Intermountain Station to the position of research center leader in the Blue Mountain Province. Even the low precipitation of 1949 had its good aspects.

Over most of the range country of eastern Oregon and Washington, precipitation was low in 1949. Many areas received from one-third to one-half of normal precipitation from April 1 to October 1; in all of eastern Washington the average precipitation was only one-half of normal during this period. As a result forage production was low and experimental and administrative seedings made during the fall of 1948 and the spring of 1949 were relatively poor in success.

On the other hand, this low precipitation of 1949 had its good aspects. It tempered the judgment of range men, especially in the field of range reseeding. Few of the men had gone through the drought period of 1923 to 1936. The range research program was started in 1937 and the range reseeding research in 1945. A series of relatively good years since the initiation of research work have caused over-optimism on grazing capacity, species adaptable for reseeding, and methods of seeding. The high precipitation of 1948 bred carelessness in observing fundamental principles of range reseeding. Nothing but a year like 1949 could have been so effective in sharpening the judgment of range research and administrative men, putting to critical trial the grasses in reseeding trials, demonstrating that care must be taken in observing certain fundamentals of range reseeding, and otherwise making all men concerned more clearly alert as to the effects of vicissitudes of precipitation.

Some major accomplishments in range research during 1949 are presented in the following statements.

Progress Made in Preparation for Grazing Management Studies

Most of the effort in grazing management research work is aimed at a detailed grazing study on a series of twelve pastures at the Starkey Experimental Forest and Range. This phase of work is being delayed because of financial inability to get the necessary fences, water developments, and roads constructed in one or two years. Slow but sure progress is being made in the completion of improvements. Quarters for the crew, and fences and water developments for six of the pastures are nearly completed.

In a sense, then, this work is marking time pending completion of the necessary physical improvements. But this is not strictly true because the delay is permitting the development of more efficient methods

of sampling the vegetation, continual review and improvement of plans for the grazing study, work toward incorporating the collection of soils data into grazing studies, and otherwise strengthen the basis for the long-time study which will be begun as soon as the improvements are completed.

During 1949 an exploratory survey was made on one of the 600-acre pastures to see what possibilities there were for correlating soil characters with vegetation. Even though the report has not been completed on this study many promising leads were found. It is expected that this survey will be extended to other pastures as rapidly as time permits, and then the general principles will be checked on other ponderosa pine ranges of eastern Oregon.

Utilization in any one year is an unreliable basis for making adjustments in stocking if not accompanied by records of relative forage production. This is shown by the records from Starkey Range where data have been collected since 1940. A summary of the data for bluebunch wheatgrass and Idaho fescue, shown in the following table, also re-emphasizes that open grassland parks are grazed much more heavily than adjacent forested areas.

Average Utilization on the Starkey Experimental Forest and Range During the Period from 1940 to 1948
(Exclusive of 1943 and 1946 when estimates were not made)

Species and range type	1940	1941	1942	1944	1945	1947	1948	Average
Bluebunch wheatgrass								
In grassland type	68	69	40	63	39	39	54	53
In conifer type	60	43	30	50	38	30	42	42
Idaho fescue								
In grassland type	50	52	35	40	37	27	47	41
In conifer type	48	43	28	34	28	15	31	32

Sampling studies point way to more efficient methods. Studies conducted during the 1947 and 1948 field seasons showed clearly that subsampling and double-sampling are two effective devices for increasing the efficiency of sampling native vegetation. The optimum number of plots per cluster, and clusters per type based on the variation in abundance of all species, relative cost, and proportion of total acreage occurring in each type on the area are shown in the following table:

Range type	Plots per cluster	Clusters per type	Total plots	Sampling error of mean
				Percent
Open grassland	5	4	20	10
Open forest	3	58	174	8
Dense forest	3	6	18	15
Total		68	212	

Studies of double sampling using weight estimates and weights from clipped plots showed the optimum number of clipped plots to estimated plots to be in the ratio of 1:5.

The sub-sampling study was repeated in the summer of 1949 to secure a better idea of the intensity of sampling that would be needed to sample change in vegetation from year to year and also to check the optimum ratio of harvested plots to those estimated by the weight-estimate method.

Condition and Trend of Summer Ranges

To tell whether summer ranges are getting better or poorer and what the present condition is in relation to potential production is one of the most perplexing problems with which the range manager is faced. He must be able to tell whether use by livestock and big game animals or by big game alone is satisfactory. Moreover, the criteria and methods he uses in making these determinations must be so selected and designed that two different individuals examining the same range can arrive at reasonably comparable answers.

Reasonably satisfactory criteria for meadows and subalpine grasslands were worked out by Pickford and Reid. No criteria are available, however, for the other types of grasslands included in the forests, and the ponderosa pine ranges. The latter type makes up 89 percent of the summer range by area and 65 of the grazing capacity. Neither is an acceptable procedure available for carrying out determinations of condition and trend on entire allotments.

The first step toward filling this huge gap was made during the time Kenneth Parker was in this region last summer. Personnel from Range Research and the Division of Wildlife and Range Management cooperated with Parker in setting up a check list for the determination of condition classes and trend for grasslands in the ponderosa pine zone (other than those in meadows.)

Initial steps toward filling another portion of the gap were taken this summer with the establishment of a random sampling system on an

entire range allotment on the Malheur National Forest. This sampling system was set up in such a way that accuracy and costs of utilization estimates made this summer can be combined to determine the most efficient sampling system to use in determining utilization on forest allotments. This same sampling system will be used early next summer to determine cost and accuracies secured in the determination of condition and trend on an entire allotment and from these the most efficient sampling procedure for condition and trend. All of this work is being carried on cooperatively between Administration and Research.

The prevalence of frost heaving in native grasslands as well as in reseeded stands was forcibly emphasized during the work this summer. No definite information on the mechanics of frost heaving on range lands and factors responsible for its occurrence is available. It is almost impossible to use pedestaling of bunchgrasses as a criteria of condition and trend with any degree of reliability. Further definition of the importance of frost heaving, how it takes place, and how pedestaling of plants can be interpreted is most essential.

Emphasis is still being given to observations on totally protected areas and areas subjected to different intensities of use in an endeavor to develop as quickly as possible at least tentative criteria for condition and trend of ponderosa pine summer ranges.

Logging Causes Immediate Drastic Reductions in Forage Production

On the summer ranges of eastern Oregon and eastern Washington logging is one of the major factors affecting range livestock economy. Nearly all of the ponderosa pine type which makes up two-thirds of the total summer range grazing capacity is being or will be logged over. Consequently, the significant ecological changes that accompany logging are of major importance, and should be recognized in the preparation of range management plans. To do so, however, requires that much more knowledge be secured about the immediate and long-time effects of logging on ground cover and grazing capacity. It was to this end that a study was initiated in 1945.

From a series of temporary mile-long transects in several logging shows it was found that the immediate effect of logging was denudation of an average of 22 percent of the ground. All of the grasses, weeds, and shrubs were removed from this denuded ground by roads, skid trails, and landings. In addition, about 9 percent of the ground is covered by slash, making a total of nearly one-third of the area not producing available forage immediately after logging.

A series of permanent transects, each 10 chains in length and established before logging, present a picture of the effect of logging on forage production a year after logging. From these transects, which averaged higher in denudation than the temporary transects, it was found that the reduction in total density of understory vegetation a year after

logging ranged from 30 to 49 percent. Perennial grasses suffered a reduction ranging from 40 to 60 percent; shrubs from 0 to 60 percent, depending on species present; and weeds from 10 to 20 percent.

The effect of this differential reduction in the three classes of understory vegetation where perennial grasses had been dominant was to cause the weeds temporarily to become the major component. Wild strawberry (Fragaria spp.), Waldo lupine (Lupinus mucronulatus Umatillensis), heartleaf arnica (Arnica cordifolia), woollyweed (Hieracium scouleri), and western yarrow (Achillea lanulosa) on some study areas have been actually able to increase their densities in the first growing season after logging. These instances of recovery can be attributed to the ability of these weeds to reproduce by stolons, to regenerate new tops from fragmented and severed rhizomes or rhizomes 6 to 7 inches deep in the soil.

Shrubs with large, sturdy stems and deep roots were not damaged materially, but less sturdy shrubs such as common snowberry (Symphoricarpos albus) and shinyleaf spirea (Spirea lucida) showed considerable reduction in density.

Type of soil, steepness of slope, spacing of roads, use of ground or arch skidding, length of logs, and types of slash disposal are factors influencing the amount of ground denudation.

The results of this study clearly show that logging (timber harvest), as currently practiced, induces immediate reductions in grazing capacity of such magnitude that there must be careful correlation of range management plans with plans for timber harvest. Continued observations on the permanent transects will tell how long the effects observed persist.

Reseeding Research Showing Where to and Where Not to Reseed

In the Pacific Northwest the range reseeding research program is beginning to provide a sound basis for action programs. These studies, begun in the fall of 1945 and 1946, are now reaching sufficient age that fairly conclusive recommendations can be made. Studies are showing not only what and how to seed but are showing areas where it is not yet time to move ahead into a pilot seeding or action seeding phase. In cooperation with the Division of Wildlife and Range Management the results from this station's studies are now being incorporated into a range reseeding handbook for in-Service use in the Pacific Northwest Region.

Reasonable assurance of successful reseeding on better sites, skid roads, and burns in the ponderosa pine zone and in the adjacent sagebrush type has been demonstrated. All of the answers have not been secured. The most foolproof methods are not yet available, nor are the tests of species exhausted. But the likelihood of getting good stands of grass is high.

On better soils of the grassland openings, along skid roads and landings and on burns in the ponderosa pine zone, timothy and orchardgrass have proven the two consistently best species. Other grasses which have been found widely adaptable are intermediate wheatgrass, pubescent wheatgrass, Tualatin tall oatgrass, and smooth bromegrass. Of less widespread adaptability but very useful in some locations are crested wheatgrass, slender wheatgrass, Canada bluegrass, and beardless bluebunch wheatgrass.

From the nurseries in the ponderosa pine zone some additional species and several strains of the species listed above have shown promise and are worthy of more widespread test in range trials. Some of the additional species are sheep fescue, (Agropyron amurense), erect brome (Bromus erectus), Kentucky bluegrass and bearded wheatgrass (Agropyron subsecundum). Two legumes, birdsfoot trefoil (Lotus corniculatus) and bramblevetch (Vicia tenuifolia) have shown up very well and may have real promise for the better sites within the pine zone.

It is becoming clear from trials in the nurseries that some strains of range grasses now being put into commercial production are not too well adapted for use in the pine zone. Other strains of the same species are well adapted. It is necessary to continue the careful screening of strains as well as of species because it is apparent that there are as great differences in adaptability of strains as there are between species.

In the sagebrush type adjacent to the pine zone the methods for eradicating sagebrush, planting the seed, and species to use are pretty much the same as found in the Intermountain Region. Siberian wheatgrass, bluebunch wheatgrass, and crested wheatgrass are the best species for the drier portions of the type, and bluebunch wheatgrass, crested wheatgrass, pubescent wheatgrass, and intermediate wheatgrass for sites with a little higher precipitation.

Some sites are still problems. Even though considerable research effort has been devoted to developing satisfactory procedures for use on scab ridges, the pumice soils of central Oregon and badly depleted meadows in central Washington, there is still no satisfactory basis for an action program.

Probably as much effort has been devoted to the problems of the scab ridge types as to any other type in need of reseeding. It is one of the region's major summer range reseeding problems. The soil has been badly depleted, the surface soil and organic matter are almost completely absent, and the competing vegetation is tarweed (Madia glomerata), other annuals, and spring perennials such as onion, camas, shootingstar, and fawnlily. Moreover, the ground is usually extremely rocky.

Intensive methods trials begun the fall of 1945 clearly showed that spring cultivation and spring seeding was the most satisfactory

procedure. But, because of snow-blocked roads and inclement weather it is almost impossible to get any sizable area seeded at the time ground conditions are just right. As a result, the method proved impractical for use in action programs. A new methods study was started this summer incorporating the most desirable methods from the previous study in comparison with other possible methods for eliminating the competition and planting the seed.

Not only is there shortage of desirable methods but also of desirable species. The soils are so poor and devoid of organic matter that the choice of species is extremely narrow. Pubescent wheatgrass, intermediate wheatgrass, erect bromegrass, Canada bluegrass, sheep fescue, and Chewings fescue are the most desirable species. Even with these it has not been possible to keep good stands until maturity. A high intensity of frost heaving is one of the principal barriers to establishment and survival of seeded species. Frequently stands two and three years old suffer high losses from frost heaving. This points to the necessity of using very strongly rooted or rhizomatous species which will persist on sites of low fertility.

It is apparent from the studies conducted so far that a much longer period of total deferment from grazing use is going to be necessary on these scab ridges than is necessary on more favorable sites. Four to five years may be necessary to permit the seeded species to become firmly established.

In the pumice soils of central Oregon only moderate to slight success has been attained from experimental and administrative seedings. The soil is a coarse, pumicy sand, low in fertility and organic matter. Consequently, it has a low moisture-holding capacity and even though precipitation in the forested areas is favorable from the standpoint of grass the site is droughty. Moreover, there is a high intensity of frost heaving. Once again rhizomatous species such as intermediate wheatgrass and strongly rooted grasses such as Idaho or sheep fescue appear to be needed. Even though there has not been much experimental work in this type, the work that has been done, plus the slight success for administrative seedings, points to the necessity for much more intensive work before extensive administrative seedings on areas disturbed by logging or depleted by overgrazing are seeded.

On the high, badly depleted meadows of central Washington the situation is the same as far as moving ahead on administrative seedings is concerned. Here there is a combination of badly depleted soils, heavy pressure by rodents, a severe infestation of Pacific grass bug (Irbisia pacifica) and other limiting factors. Considerable effort has been put into experimental work with almost no success, and administrative pilot plantings have been only slightly more successful. Here one of the essential criteria of adaptable grass species must be resistance to attack by Pacific grass bug.

In the work on reseeding in the cheatgrass ranges at the lower edge of the forest in central Washington to reduce fire hazard and increase forage production there is considerable progress. Species that stay green late in the summer and which compete effectively with cheatgrass under the low moisture conditions prevailing are intermediate wheatgrass, big bluegrass, tall wheatgrass, Russian wildrye, and pubescent wheatgrass. But effective methods are still lacking. In an intensive methods trial, plowing has been the only method by which competition from cheatgrass has been effectively reduced and good stands of seeded species established. Burning at different dates during the summer, which was found effective in the Intermountain Region, has not proven so effective here. Since plowing is impossible on the steep and rocky sites that characterized the margin of the forest, search for effective methods must be continued.

Big Game-Livestock Relationships

The needs for forage by big game animals on summer ranges of eastern Oregon and Washington must be taken into account in grazing management plans. This is emphasized by the fact that the demand by big game on summer livestock range is estimated to be equal to one-quarter of its total grazing capacity. To secure some of the needed information on relative forage use by livestock and big game and the relative ability of some of the major browse species to stand, grazing studies were begun in 1945 by the Division of Wildlife and Range Management of Region 6. These studies were taken over by Range Research in 1947 and were either terminated during the summer of 1949 or will be terminated during the winter of 1949-50.

During the spring and summer of 1949, Range personnel of this station cooperated with Miss Doris Hayes of the Washington office Division of Dendrology and Range Forage Investigations in the preparation of a key to winter and summer characteristics of common shrubs of eastern Oregon and Washington.

Browse species vary widely in forage production from year to year. Yield data from snowbrush (Ceanothus velutinus) are shown in the following table as an example of the extent of this variation.

Four-Year Production Record of Snowbrush on Three Whitman National Forest Resistance Study Plots
(Dry weights in grams)

Plot	1945	1946	1947	1948
Dutch Creek	635	3,785	2,859	5,173
Blue Spring	762	2,255	1,245	2,475
Elkhorn Spring	629	3,380	2,936	4,979
Average	675	3,140	2,347	4,209

Other browse species are showing a similar wide variation in forage production from year to year. If these variations are confirmed in final analyses it is apparent that browse species are much less reliable forage producers than formerly assumed.

Heavy winter clipping is detrimental to snowbrush. At each of three locations three bushes of snowbrush were clipped at each of the following five intensities: 95, 75, 50, 25, and 0 percent of the current twig growth. Clipping was done in the late fall. No production data are available for the unclipped shrubs but for those subjected to the different intensities of clipping the data are presented in the following table:

Total Yields of Snowbrush Under Four Intensities of Clipping
(From a combined analysis of three locations)

Intensity of clipping	Average 4th year yield
Percent	Grams
25	604.4
50	699.6
75	525.0
95	506.6

These data show the greatest production from plants from which 50 percent of the current twig growth was harvested and lowest for the 75 and 95 percent clippings. Even though no production data are available for the unclipped plants it was clear from observation that they were not producing as much as shrubs in the 25 and 50 percent clipping intensities. This would mean that some harvesting is essential to maximum production. Conversely, too heavy clipping is detrimental as shown not only by total production but by twig length, amount of fruiting, and total size of shrub.

These conclusions from snowbrush, which is an evergreen, are slightly different than appears from studies on bitterbrush, rabbitbrush, and oceanspray. In these species heavy intensities of clipping during the winter are either not as detrimental or the injurious effects take longer to manifest themselves. Final data on these have not yet been analyzed.

Plans for 1950

During 1950 it is planned to continue the existing studies on range reseeding and effect of logging as called for in the respective study plans. Most of the existing work on big game-livestock relationships will be discontinued pending completion of the analysis of the data from present studies. At that time steps may be taken to initiate some new studies. Research on condition and trend will be intensified and a

strong effort will be made to draw up tentative standards for the ponderosa pine type. In addition the contemplated study of intensity and method of sampling for the determination of condition and trend on an allotment basis will be conducted. Construction of needed improvements on the Starkey Experimental Forest and Range will continue as rapidly as available funds permit.

Plans for 1950 include the completion of the following publications and reports:

1. Completion of problem analysis for east-side range territory of Oregon and Washington in line with the streamlined approach discussed at Ogden seminar.

2. In cooperation with the Division of Wildlife and Range Management of Region 6 the preparation of a range reseeding handbook for in-Service use.

3. Publication of report on area of ungrazed ponderosa pine range (Meeks Table) and adjacent heavily grazed ponderosa pine range (Devils Table).

4. Publication of the report "Application of the sub-sampling method for sampling native vegetation on ponderosa pine summer ranges."

5. Mimeographed station research note on study of methods of seeding on scab ridges.

6. Publication of report on immediate effects of logging.

7. Release of research note and possibly journal article on effects of different intensities of clipping on browse species.

FOREST MANAGEMENT RESEARCH

During 1949 activity in Forest Management Research increased for the fourth consecutive year. All of the six major experimental forests on the national forests—Wind River, Cascade Head, Blue River, Port Orford Cedar, Pringle Falls, and John Day—were operating. Other test cuttings were pushed forward on four additional experimental areas on the national forests—Henderson Creek, Fall Creek, Walker Mountain, and Kugel Creek. Study programs on two cooperative experimental forests on private lands—Voight Creek and McCleary—went ahead vigorously according to plan. Two new cooperative experimental forests on private lands—Hemlock and Hood Canal—were established and study plans developed. Additional numerous small-plot studies were conducted throughout the region on both private and public forests.

Major emphasis remains in the field of applied research. The guiding objectives are: (1) to obtain quickly, sound intermediate answers to our most pressing forest management problems, and (2) at the same time make the fundamental study installations that will yield in the future basic information needed to gain the full benefits of increasingly intensive management. Current efforts provide:

(1) a strong program of applied forest management research in Douglas-fir region second growth;

(2) a strong program of applied research in Douglas-fir region old growth. There is a serious weak spot here, however, in the extensive mixed stands in the southwestern Oregon interior;

(3) a strengthened, but still inadequate, applied forest management program in the ponderosa pine region;

(4) a deficient but expanding research program in artificial and natural regeneration and stand improvement;

(5) an expanded forest soils study—though still inadequate to the needs;

(6) increased (though grossly deficient) program of ecological and other fundamental studies;

(7) activity in forest mensuration on little better than a plot maintenance basis and greatly below the needs;

(8) fire studies modestly expanded, but far below the level called for by the critical fire control problems.

Four technical foresters were added to the staff: Hayes as center leader at Roseburg; Sowder at Bend, in charge of pine management studies; Cramer in fire studies and Carmean in soils study, both headquartered in Portland. Twerdal, formerly of the Puget Sound Center, returned from graduate study at Yale and transferred to the new Division of Flood Control Surveys.

Training of personnel went ahead both as a part of the official work program and by individual initiative. The policy of detailing technicians to work assignments at centers other than their own was continued. In this the objective is to build appreciation of local problems in terms of regional conditions and to give training in research methodology under several supervisors. Dahms was detailed to Washington for three months for the statistical seminar. Hayes and Sowder were trainees at the 8-day R-6 administrative and resource management training session at Wind River. Steele was on educational leave the first half of the year doing graduate work at the University of Michigan. Ruth was on similar leave the last

four months of the year for graduate study at Oregon State College, having won the Weyerhaeuser scholarship for 1949 at that institution.

In addition to the work on their own projects, members of the division cooperated extensively in the projects of others. A considerable part of Matson's time was devoted to cooperation on a variety of work with the Forest Utilization Service and on the financial aspects studies of the Division of Forest Economics. The staff at the Siskiyou-Cascade and at the Puget Sound centers assisted in the study of Douglas-fir log grades under the leadership of the Forest Products Laboratory. The Puget Sound and Wind River staffs also cooperated with the Laboratory in the study of Douglas-fir second-growth wood quality. Likewise, the staff at the Deschutes center cooperated in the Laboratory study of second-growth ponderosa pine wood quality, and members of the Siskiyou-Cascade center assisted in the cooperative study of Port Orford white-cedar second-growth quality. The staff at several centers assisted the Division of Forest Economics in the lumber census. Tarrant participated in soils phases of the Flood Control Surveys. There was more than the usual amount of participation in the emergency fire control job on the national forests.

Project activities during 1949, significant findings, and plans for 1950 are given in further detail below.

Douglas-Fir Second-Growth Management

A promising program of applied management research for Douglas-fir region second growth was in operation during 1949. Ground work was laid for the accumulation of increasingly important information in the years to come. In addition, results already apparent are beginning to define the stand conditions, market opportunities, and operating methods that permit the making of intermediate harvest cuttings on a stand-improvement basis and at a current net profit.

Most favorably situated with regard to markets are the King Creek experimental plots and Voight Creek Cooperative Experimental Forest on lands of the St. Paul & Tacoma Lumber Company some 20 miles from Puget Sound. At King Creek an experiment to test the relative advantages of high versus low thinning was laid out in 27-year-old site III Douglas-fir. The high thinning removed the rougher, poorly formed trees at the rate of 213 cubic feet per acre, or 19 percent of the total stand. Thinnings were marketed as sawlogs and smelter poles; horses used in skidding, and returns from the cutting more than paid the full cost of operation. Check and low-thinning compartments were laid out, but the low thinning will not be made until the trees which should be cut are large enough to be merchantable—probably 10 years hence. By that time the high-thinning area should be receiving its third or fourth cut.

At Voight Creek the comprehensive thinning experiments on a commercial basis in 38-year-old site III Douglas-fir went ahead vigorously. Thinning is done by a 4-man crew, 2 skidding horses working singly, a

small power saw, and a home-made truck loader. Three severities of thinning are being tested. The cut averages 1,087 cubic feet per acre, but ranges from less than 480 to more than 1,780 cubic feet, or from 11 to 41 percent of total stand on the various compartments. Trees cut range from 6 to 24 inches in diameter and average about 9 inches. The principal products of the thinning are sawlogs, smelter poles, standard poles, car stakes, mine props, and fence posts. Value of the harvest loaded on the truck in the woods averaged $180 per acre. Experience gained during the year resulted in significant improvement in operating efficiency. Output per man-hour now averages 11.3 cubic feet. It was increased 63 percent by more efficient layout of skid roads, crew organization, and marking practice. Two factors found to influence production costs most importantly are skidding distance and tree size. There is every indication that costs will decline and returns increase at subsequent thinnings which will follow at 3-, 6-, or 9-year intervals, depending on severity of first cuts.

In the years ahead these and other second-growth experiments under way should give well-based answers to such vital management questions as: What is the optimum growing stock to carry? What is the best volume to remove in any one cutting? Which tree classes should be favored? How long should we wait between cuts for best results? What is the best balance between the volume of yield removed in intermediate cuts and that left for the final harvest to obtain greatest volume and value production?

Initial thinnings were made at McCleary Experimental Forest in 50-year-old site II Douglas-fir in cooperation with Simpson Logging Company. Here the stand, averaging 25,000 board feet per acre, was given a 16 percent thinning, removing from the average acre 4,000 board feet, chiefly in rough dominants and badly misshappen trees. Harvest from road right-of-way brought the removal to 25 percent of the total on the 40-acre area operated. Trees cut ranged from 10 to 32 inches in diameter and averaged 18 inches. The company is using the proceeds of the stumpage sales on the tract to finance construction of access roads. The outlook is that by next year the main road system will be paid for by receipts from about 25 percent of the volume and an even smaller proportion of the value of the existing stand. Thus, there will be no road-building cost against the remaining timber, which, in a 10-year period, should grow back to its present volume, but in considerably improved quality. Logging was by tractor, which skidded in lengths up to 50 feet to the landing where logs were bucked to 16 feet and loaded for trucking to the mill. Logging injury to the reserve stand was slight.

Second thinnings were completed on two areas in the Olympic National Forest. At Walker Mountain in 75-year-old site IV the cut removed 5 cords per acre in trees averaging 10 inches in diameter. Original thinning was partly at age 60 years, partly at age 64, and growth between thinnings averaged 151 cubic feet, or 830 board feet, Scribner rule, per acre per year. Volume of growing stock was one-fourth less on the thinned than on the unthinned check area, but increment on the thinned was almost

equivalent and in trees of better quality. The experience at Kugel Creek was better. Here the second thinning in 50-year-old site III Douglas-fir yielded 17½ cords per acre in trees averaging 12 inches in diameter. Cutting was done by a regular contractor who with three men, a horse, a power saw, and a 1½-ton truck cut the trees into 50-inch pulpwood and delivered it 40 miles away. Production per man-hour averaged 16 cubic feet, and the operator's records show a margin of 75 cents per cord after allowing for all costs. This stand was first thinned in 1937 at age 38 years. Growth since has averaged 283 cubic feet, or 1,528 board feet, Scribner rule, per acre per year. Growth on the thinned area averaged 13 percent more than that on the unthinned, although it has 25 percent less growing stock.

Intermediate harvest cutting experiments were extended to 90-year-old site III Douglas-fir at Fall Creek on the Willamette National Forest. Here a 25 percent stand improvement cut in the 70-acre tract yielded about 15,000 board feet per acre in trees ranging from about 10 to over 30 inches in diameter. On a lumber tally basis, logging cost was $19 per M board feet, milling $26 per M. After deducting all costs, the margin remaining for profit, risk, and stumpage was $8 per M. Lumber grade recovery averaged:

Select structural	7 percent
No. 1 common	78 "
No. 2 common	8 "
No. 3 common	7 "
Total	100 percent

Clearly, second-growth Douglas-fir timber will produce high-grade structural and high-common lumber. At Fall Creek, 85 percent of the yield from an improvement cut was in this category. These results compare well with the findings from four such studies at mills in the Puget Sound area last year in typical 50- to 80-year-old Douglas-fir. At those mills, 80 percent of the lumber produced was No. 1 common and better.

Next step in the age-class sequence of applied forest management tests is in 108-year-old Douglas-fir site III at Panther Creek on the Wind River Experimental Forest. An access road into this area was completed during the year as was the ground layout for intermediate harvest cuttings and regeneration cuttings combined to make a commercial sale of about 3½ million board feet. Here the objectives are (1) to reduce mortality caused by the Poria weirii root rot fungus and by the Douglas-fir bark beetle, (2) to stimulate increment of the highest quality trees in the stand, (3) to regenerate brushy and poorly stocked parts of the stand in clear cuttings ranging from several acres to more than 20 acres in area, and (4) to return a fair profit to the timber operator. Prospects are good for attaining all of these objectives and in addition provide a reasonable stumpage return.

The program of test cuttings in spruce-hemlock at Cascade Head Experimental Forest moved forward on schedule. Two sale-unit tests of intermediate harvest and regeneration cuttings aggregating 13 million board feet were completed during the year. The resulting records of costs are being analyzed for the different sizes of setting and methods of logging— tractor skidding, horse skidding, and high lead. Corresponding records of logging damage and surface disturbance in partially cut stands, and marginal windfall on the clear-cuts are being compiled. Plots to provide records of following growth, mortality, and regeneration under varying contrasting treatments are installed. Four additional small sales totaling about 1.4 million board feet were made. Three of these are intermediate harvest cuttings in spruce-hemlock; one combines regeneration and stand improvement cuttings in alder. The hypotheses being tested here result from basic silvical studies carried on over the past four decades. For example, these show that brushy areas in the uncut forest frequently revert to dense, aggressive brush patches after cutting. Thus, in the layout of logging, such brush threat areas are identified ahead of time and scarified as part of the logging process. This year a 5-way regeneration test was installed on clear cuts that had been so treated. Establishment and growth of the new stand is being studied following these treatments:

1. Clear-cut, as little surface disturbance as possible— natural regeneration.

2. Clear-cut, surface disturbed, slash burned—area planted.

3. Clear-cut, surface disturbed, slash burned—natural regeneration.

4. Clear-cut, surface disturbed—area planted.

5. Clear-cut, surface disturbed—natural regeneration.

All the treatments are made as a part of the regular cutting layout procedure, commercial logging, and follow-up KV provided in the sale contract.

Status, objectives, and results to date were summarized in the new "A Guide to Cascade Head Experimental Forest" which was published during the year.

Study of the silvical characteristics of young Port Orford white-cedar was started at the Siskiyou-Cascade center. Although the species makes excellent juvenile growth, no cases were found where cedar growing in mixture with Douglas-fir and other rapidly growing conifers could maintain a dominant position in the stand beyond about 25 years. Heavy deer-browsing aggravates this condition and permits other species to more rapidly overtop the cedar. Once in the understory, cedar was found to survive suppression well. Growth declined to a very slow rate, but where any release had occurred the response in increased growth was excellent.

Possibilities for the management of such mixed stands include:

(1) Without giving any cultural treatments, attempt to market the cedar as small poles or other small product when the associated species are harvested. Returns for the cedar would probably be low.

(2) Give no cultural treatments, but attempt to preserve the cedar understory when the other species are harvested. Since cedar responds well to release it should put on a good volume of valuable increment for harvest during the second rotation for the other species.

(3) Conduct thinnings to release the better cedars and attempt to make cedar sawlogs in one rotation. This has promising possibilities but will require a market for thinnings.

Which of the above will be the best procedure can be determined only after additional yield and cutting studies have been made.

Two new second-growth experimental forests were established: the Hemlock Experimental Forest in western Grays Harbor County, Washington, in cooperation with the St. Regis Paper Company and the Hood Canal Experimental Forest in Kitsap County, Washington, in cooperation with the Pope & Talbot Lumber Company. Mapping and inventory of these areas were completed during the year. Experimental objectives and tentative plans for development have been agreed upon with the owners and access road construction is well started. Experimental cuttings and planting experiments are scheduled to start next year.

The station's Douglas-fir second-growth management committee continued to give guidance to the research program for young forests. This 10-man committee also cooperates in the coordination and publication of the results of such research. Principal job of this group for the year was revision of the manuscript "Your Trees - A Crop, How to Grow and Harvest in the Douglas-Fir Region." The State Forestry Departments of Washington and Oregon and the forest schools of the two States have arranged to print this cooperatively and distribute it in quantity in 1950. This is prepared to serve as a manual for nontechnical owners and operators of wood lots and small tracts of young forests in the Douglas-fir region. A field study of second-growth Douglas-fir cuttings was sponsored by the committee during 1947 and carried out by station technicians. A manuscript describing results of this work was prepared during 1949. Following review and revision it is proposed to publish this in multigraph form in 1950. The next big job for the committee will be revision and printing of the technical manual "Management of Second-Growth Forests in the Douglas-Fir Region," which the group prepared late in 1947 and which was distributed as a station multigraph in 1948.

Douglas-Fir Region Old-Growth Management

Three approaches are being used in the search for better methods of effecting the transformation of wild, virgin forest to thrifty, managed stands: (1) Small plot installations made years ago are being periodically re-examined, the new information analyzed and summarized. (2) Temporary plot examinations are being made to determine effects of certain significant past cuttings. (3) Previous findings and promising hypotheses developed are being tested systematically in commercial-scale applied forest management cutting experiments.

Results of new measurements of plots established in partially cut stands more than a decade ago were compiled during the year. On three groups in overmature Douglas-fir on the Olympic National Forest, stand deterioration following partial cutting continued, but at a reduced rate. Net loss during the first five years averaged 781 board feet annually. During the second five years rate of net loss averaged 254 board feet per acre per year. The record was extended for two groups of plots in mixed conifer stands on the Siskiyou National Forest. Part of the Port Orford white-cedar volume was cut from the study area a decade ago, leaving generally a medium mature Douglas-fir forest with reduced volume of cedar. The heavily cut plot has experienced a continuing net loss during the past five years, averaging 200 board feet per acre per year. White fir, hemlock, and brush are encroaching at the expense of the high-value cedar. On the lightly cut plot, however, the remaining stand, particularly the cedar, responded well to release. Net growth for the past five years averaged 936 board feet per acre per year and was in fairly high quality material.

A 260-acre tract partially cut in 1938 near Mineral, Washington, was re-examined this year. During the past 11 years the residual stand was found to have made a growth of 248 board feet per acre per year after deducting mortality but without allowing for accelerated decay caused by logging injury. The cut removed practically all Douglas-fir from the stand, converting it to a forest of hemlock and silver fir. About 10,000 board feet per acre was killed and wasted in the original logging. At the recent rate of growth (about 1/3 of the capacity of the site) more than 40 years would be required to replace this loss. In retrospect, it appears that, if this loss were unavoidable, a greater total yield would have been obtained by delaying cutting until utilization opportunities improved. A summary report on results of partial cuttings to date is planned for 1950.

Working plans were prepared for a temporary plot examination of areas clear cut by the staggered system. Such a survey is scheduled for next year in western Oregon in cooperation with the national forests.

Systematic applied forest management test cuttings in old growth were in progress during the year at Wind River on a 9-million board-foot harvest and at Henderson Creek on a series of settings totaling 11 million board feet. Also during the year "rehabilitation" cuttings totaling 5 million board feet were laid out at Port Orford Cedar Experimental Forest in stands that were high-graded for cedar a decade ago. At Blue River

systematic inventory of silvical conditions was completed for the area in which initial cuttings are to be made. Prescribed cuttings in the first series total 24 million board feet—about 30 percent of the stand in the initial operating area of about 1,200 acres. A logging and road plan facilitating these cuttings and servicing with equal efficiency all of the adjacent timber was laid out on the ground. At year's end appraisals for the first sale were made and plans completed to start cuttings next year.

First step in the applied forest management approach is an analysis of forest conditions and a prescription of silvicultural treatments. Next step is to lay out a road and logging plan that will, insofar as possible, permit the making of indicated cuttings efficiently. The hypothesis is that highly flexible systems of both staggered setting clear cuts and stand improvement partial cuts are needed to meet the varying pattern of silvical conditions and silvicultural objectives. Some of the detailed objectives and procedures for attaining them are described by Aufderheide in "Getting Forestry Into the Logging Plan," published in The Timberman during the year.

Cooperating with the Division of Flood Control Surveys, the cuttings at Blue River are being laid out to test the effects of logging on stream flow and erosion. A stream gaging station was installed on main Lookout Creek this year and sites for such stations were located on three selected tributaries.

Pine Management

Harvest cutting studies in virgin ponderosa pine are progressing by re-examination of sample plots installed decades ago. The results in turn are combined with the findings of the Bureau of Entomology and Plant Quarantine and others and subjected to systematic test through large-scale applied forest management cuttings.

For example, additional results came this year from plot samplings of some 35,000 acres of earlier cuttings in the Bear Valley area of the Malheur National Forest. Application of "value selection" cuttings 10 years ago resulted in a net growth during the following decade of only 28 board feet per acre per year, although the reserve stand totaled about 11,000 board feet per acre. Value selection modified by silvicultural considerations in marking trees above 22 inches in diameter yielded a net growth of 43 board feet per acre per year. In contrast is the growth obtained on another set of plots in the valley on which silvicultural guides were followed throughout. Here net growth averaged 152 board feet per acre per year. Other results from plot studies at Pringle Falls show that the first step in putting virgin pine stands into a condition of net growth can be accomplished by silvicultural cuts removing as little as 20 percent of the total stand.

Ground layout for extending the tests of light sanitation-salvage cuts at Pringle Falls and preparing the stand for a series of second-cycle

cutting tests was completed this year in cooperation with the Deschutes National Forest. The plan is to make this experimental harvest by commercial timber sale of about 5 million board feet next year.

At John Day Experimental Forest, in cooperation with the Whitman National Forest, 7 miles of access road were constructed and systematic cutting tests covering some 350 acres were laid out. Four million board feet will be harvested in this first experiment. The planned cut is 39 percent ponderosa pine; 61 percent other species. Light sanitation-improvement, current regional marking practice, and heavy cutting will be contrasted side by side. On some compartments ponderosa pine will be favored in the harvest and follow-up cultural release cuttings. In others the best individuals in the stand regardless of species will be favored. Cuttings are scheduled to start in 1950. Long-term plans call for study of cutting effects on forage and problems of converting forest to range.

Preliminary study of pine needle blight on John Day Experimental Forest was made in cooperation with the Office of Forest Pathology and a test plot established. Conditions were found to be more serious than realized at first, and additional examinations will be made in the spring.

Management of second-growth ponderosa pine study proceeded with the completion of the second series of experimental cuttings in the 105-year-old forest at Lookout Mountain. Light and medium intermediate harvest cuts removing 3,500 and 6,100 board feet per acre, respectively, were made in the original stand averaging more than 25,000 board feet per acre. The objective is to reduce risk of insect attack, stimulate the growth of the best trees for future harvest, and maintain the high rate of increment in this stand for as long as possible. Plot records show recent periodic annual growth rates in excess of 500 board feet per acre.

Indications of decay resulting from bark beetle activity in this stand brings a new consideration to the attention of timber markers. A previous hypothesis maintains that surviving trees in which beetle attacks had been "pitched out" may be better insect risks than normal trees. However, if decay is thus introduced, such trees will decline in efficiency as growing stock. Decay associated with fire scars was also found in this stand. Intermediate cuttings should improve both situations. Follow-up studies in cooperation with the Office of Forest Pathology are planned.

The lumber grade recovery from sample logs of this 105-year-old pine averaged:

Green lumber grade	Close grown timber	Moderate to open grown
No. 2 common	52 percent	39 percent
No. 3 common	35 percent	40 percent
No. 4 common	12 percent	19 percent
No. 5 common	1 percent	2 percent

Generally poorest quality trees in this immature forest were cut and they yielded quite gratifying proportions of high common lumber. It is obvious, however, that pine should be pruned at an early age if clear lumber is to be obtained in rotations now being planned.

"Preliminary Guides for the Management of Lodgepole Pine in Oregon and Washington" by Mowat was issued as Research Note No. 54 during the year.

Regeneration Studies--Natural and Artificial

With the mounting costs of planting, interest has intensified in methods of promoting natural regeneration and in ways of securing artificial regeneration at reduced costs, such as by direct seeding or mechanical planting.

Natural regeneration. In the field of natural regeneration interest has centered on the rate of restocking in different sized openings and under different soil conditions in the Douglas-fir region. In the pine region, preparation of more favorable seed beds for natural seed fall, coupled with the harvesting of a higher percentage of the more undesirable species to reduce the seed source, was tested.

Because of the relative abundance of the seed crop during the past year, a series of seed traps were set in the Douglas-fir, spruce-hemlock, Port Orford, and ponderosa pine types in order to provide a measure of the seed fall that will produce the seedlings during the coming season. In the years to come these traps will give a measure of total seed crops in terms of seed per acre as well as a measure of its distribution throughout the season. A special study of the size of the seed trap was installed at Wind River and Cascade Head testing traps from the old original size of 4 by 4 feet down to a 1-square-foot size. Using a larger number of the small-size traps makes handling more convenient and may provide a better estimate of sampling accuracy. However, these advantages are offset by the inconvenience of setting a large number of traps and the difficulty of finding these small traps as weeds and brush develop. Also, when the seed crop is light, seeds fall in a relatively low percentage of the small traps, and the labor of finding and examining blanks is wasted. Keeping in mind average densities of seed fall and ease of handling, a new size of trap midway between the two extremes was constructed. This trap, 2 by 3 feet in size, is large enough to receive one or more seeds in a normal seed fall, but small enough to carry easily.

Development of poisoning technique for seed-eating rodents has been sufficiently successful to warrant tests of poisoning to reduce the rodent population on areas of natural seed fall in order to increase the proportion of seed available for regeneration. Such tests were installed in cooperation with the Siuslaw and Gifford Pinchot National Forests during the year.

Study is under way on paired plots to test the interrelations of broadcast burning of Douglas-fir slash, restocking, and growth. It is discussed under fire studies. Present information on relation of slash burning plans to incidence of seed crops was summarized by Isaac during the year in "Can We Save the Seed Crop?" and distributed as Research Note No. 56.

A regeneration survey of eight cut-over areas in the mixed fir-pine type of southern Oregon was made during the past summer. As in other parts of the fir region, northerly slopes were found to be more favorable for regeneration than southerly and on the north slopes the steeper slopes were more favorable. Detailed analyses of findings are under way.

Studies of regeneration of Port Orford white-cedar were made to determine if there are ways of increasing the percentage of this highly desirable species in the new forests that follow logging operations. Port Orford is found to be a relatively prolific seeder, more tolerant than Douglas-fir, and it apparently will reproduce more readily under shade, but grows so slowly under shade that it frequently loses the benefit of its superior tolerance. A detailed study was made of 11 clear-cut and 12 partially cut areas during the past year. Special attention was given to natural regeneration and the results are now being worked up.

The more important Port Orford plantations were also examined during the past year. Studies to date show that this species makes excellent growth on some sites and poor on others. There is evidence that if its associates cannot be taken out at an early age as thinnings it may be necessary to grow Port Orford cedar in pure stands that are not too dense to continue rapid growth.

Problems of obtaining ponderosa pine regeneration in mixed stands where pine frequently makes its best growth have concerned our east-side foresters for years. This year, in cooperation with the Fremont National Forest, a study was installed to give information on this subject. In a mixed pine-white fir stand the fir was cut heavily, the pine very lightly in an operation approaching a shelterwood. White fir seed source was thus greatly reduced, pine seed production stimulated. This fall, with a good pine seed crop in prospect, various seedbed treatment tests were made in this area including (1) scarifying the surface, (2) broadcast burning, and (3) rodent poisoning. Seed traps are set to measure the seed crop. The results are awaited with interest.

Artificial reforestation. Efforts are under way on both private and public lands in the region to reduce costs of artificial reforestation by direct seeding, both broadcast and by hand seeding tool. One test on a field scale conducted last year at Henderson Creek came through the first growing season with about 400 trees to the acre from seed broadcast at the rate of one pound of stratified Douglas-fir seed to the acre. Thus, first season establishment and survival was about one seedling per 100 seeds broadcast. This seeding was done the first season following clear cutting,

slash burning, and rodent poisoning by thallium. The study revealed that the loss of seed between time of sowing and beginning of germination, in spite of stratification and rodent poisoning, was the greatest factor contributing toward the lack of complete success.

Studies in the establishment of conifer forests in brush-threat areas following logging in the fir region were described briefly under the section on management studies. One such experiment at Cascade Head is testing cedar, Douglas-fir, western hemlock, and Sitka spruce on comparable ground to determine which species will most successfully compete with the rapidly developing brush under varying conditions. Another similar test on the Siuslaw Forest, now in its sixth year, indicates that Douglas-fir, though less tolerant than Sitka spruce or cedar, is proving most successful in competition with other vegetation because of its faculty of fast growth.

Gains to be made by using the right seed for a given site in reforestation are receiving broader appreciation. Work started years ago in experimental plantations has demonstrated that we have superior strains of Douglas-fir and ponderosa pine and that these strains also have specific climatic limitations. A report prepared by Isaac on assignment to the University of Washington, entitled "Better Douglas-Fir Forests From Better Seed," was published during the year by the University of Washington Press.

Work has continued toward perfecting the hand seeder designed to plant a single pelleted seed in a spot, and it is planned to build several for field tests next spring. This year's tests proved that stratified Douglas-fir seed could be promptly pelleted and planted without losing the benefits of stratification. Tests of comparative field germination of pelleted and uncoated seeds are under way. One new process of pelleting using peat as the pelleting material came out during the past year and this material is being tested.

Passage of the reforestation bill authorizing a greatly enlarged planting program on the national forests brings attention to the problem of re-establishing a forest on extensive nonstocked and poorly stocked areas in both fir and pine. Particularly in pine the problems of techniques are impressive. There is an urgent need to develop ways of successfully planting brush areas.

Problems of establishing plantations on droughty areas where it will be necessary to seek out particular strains, develop special seed-producing stock, and special planting techniques likewise are in urgent need of early study. One cooperative planting study is under way with the Western Pine Association testing "Ceremul C", a wax coating to reduce transpiration and improve survival. Significant results are not yet available. Another test of planting ponderosa pine on moist sites and on dry sites is under way, and other studies of seedling survival and soil relationships are reported in the soils section.

A cooperative study with the Weyerhaeuser Timber Company and the Fish and Wildlife Service to determine animal damage to Douglas-fir in plantations has given surprising results. A 1941 plantation was practically annihilated by cattle, deer, and mountain beaver; rabbits may have helped, but they were not present in 1946. Without a record of reduction in mountain beaver and livestock and with a decided increase in rabbits, trees planted in 1946 are making good survival and growth. Rabbit damage has gradually increased but not with killing effect. Damage to date shows that animals have a decided preference for Douglas-fir as compared with hemlock or cedar.

Stand Improvement Studies

Under this heading are the studies of cultural operations designed to improve the quality or composition of the tree crop. Including pruning, weedings, liberation cuttings, and pre-merchantable thinnings these crop-tending practices are conducted at a current outlay in anticipation of increased future income.

Sample plot studies in fir at Wind River and in pine at Pringle Falls have shown that in young pole stands an 18-foot butt log can be pruned without reduction in growth rate. Costs projected into the future and matched against estimated improved values from pruned versus unpruned trees gives promise of a good profit on the pruning investment. At present it costs about 35 cents to prune one log length.

Related to both old-growth management and second-growth pruning is a study of the peeler log supply in the southern part of the fir region to which industry has so rapidly migrated. The results are given in "Peeler Potential for Southwestern Oregon" by E. S. Kotok, and will appear in The Timberman early in 1950. Briefly they show: (1) If old-growth production continues at the 1947 level the supply of quality logs in this area will last 50 years. (2) To maintain the quality timber supply for plywood in southwestern Oregon beyond this period, 2 million acres of the better sites should be put under intensive forest management, including pruning, starting now at the rate of 17,000 acres per year. Additional effort will be needed to supply quality wood for other uses.

The relationship between peeler log production and supply is much more favorable in southwestern Oregon than elsewhere. Farther north it is even more urgent to accelerate efforts to provide for tomorrow's needs for quality timber. To insure a continuing supply of quality logs in the future equal in volume to that now used by the plywood industry in the Douglas-fir region, we should start pruning now at the rate of 45,000 acres every year. Quality logs for other uses will require added effort. Only a very small fraction of this work is being done. To explain the methods and prospects for returns a guide book on pruning of Douglas-fir is in process of preparation at the Puget Sound Center. Logs from trees pruned one to two decades ago were collected and sent to the Forest Products Laboratory at Madison this year for detailed study of rate and nature

of healing and stub occlusion following pruning by different methods.

Plans have gone forward for a cooperative pre-merchantable ponderosa pine thinning and pruning study in cooperation with the Deschutes National Forest. Preliminary plans are in the making for a cooperative study on the Whitman National Forest that will include both hand and machine thinning of stagnating pine thickets. Follow-up studies in the intermediate harvest cutting of young ponderosa pine at Lookout Mountain provide for the pruning of selected crop trees and the removal of unmerchantable insect-risk trees. Five-year remeasurements were made on nine ponderosa pine thinning plots in different parts of the region and reports are being prepared. During the past year Mowat prepared a report entitled "Cutting Lodgepole Pine Overstory Releases Ponderosa Pine Reproduction," proposed for Journal of Forestry publication next year.

Forest Soils Studies

The station's forest soils studies during 1949 followed closely three main divisions of the study program:

1. Study of soil and site factors influencing tree growth.

2. Study of soil and site factors influencing artificial and natural regeneration.

3. Study of effects of forest management practices on soil.

During the year a second soils technician was assigned to a full-time study of the physical factors of soil and site as they influence Douglas-fir growth. Briefly, this study is based on intensive observations of all measurable physical factors of soil and site on sample plots in southwestern Washington. Data from these plots will be statistically analyzed and soil samples will be studied in the laboratory to determine the significant characteristics of the soil and site that are related to tree growth. Duke University, the State Forester of Washington, and timberland owners are cooperating.

The practical use of soil mapping units to determine site quality was studied on the Voight Creek and McCleary Experimental Forests in western Washington. Intensive experimental soil maps using the soil type as the classification unit were made for the two areas, and the relation of Douglas-fir site quality and the mapping unit was studied. Site quality was found to vary appreciably within single mapping units although the surveys were intensively performed. The topographic position of the timber stand was found to be very important within a single soil type. Those Douglas-fir sites onto which subsurface soil moisture tends to enter from higher lying land produce more rapid growth in all cases than those positions on which drainage was away from the site in the area studied. Thus, future forest soils classifications in the Douglas-fir region must take into consideration this factor of position-

on-slope as it exerts a powerful influence on tree growth and cannot always be measured in terms of soil development as some investigators have found elsewhere. The previously mentioned intensive plot study of soil and site characteristics should help greatly to isolate the important factors so that foresters may more accurately predict the productive capacity of land.

The study of soil and site factors influencing regeneration was continued in the ponderosa pine region of central Oregon. Again this year, as in 1948, a series of pine test plantations was established in the droughty pumice soils of the Deschutes plateau and soil moisture measurements were made at the first of each month throughout the summer. The summer precipitation in 1948 was the highest of any year since 1890 when weather records were started. In contrast, the summer of 1949 was one of the driest on record. This climatic "about face" makes observations of soil moisture levels and seedling mortality for these two years especially interesting. Preliminary analysis indicates that seedling mortality was not directly correlated with a lack of soil moisture. Rather, the amount of grass and brush competition and the method of planting were more decisive factors in seedling survival in the pumice soils. Both in 1948 and 1949 the plantation in the zone of highest precipitation suffered the greatest losses of seedlings. Apparently, in this area a well-established grass and brush cover competes strongly with the planted pine for soil moisture and nutrients. This study also shows that the pumice soils are not uniform in character but vary appreciably over comparatively short distances. Thus, careful study of intended planting areas will be necessary to adopt planting methods that best fit soil conditions.

An improved system of preplanting soil survey was developed this year with the cooperation of the Gifford Pinchot National Forest. This method is based on evaluation of seven soil and site factors and mapping on aerial photographs of planting priority ratings. Practical application of the system was made last spring when 16,750 acres of the Yacolt burn were surveyed by this method. Now the national forest has an inventory of the various planting jobs necessary on the area covered and priority classifications for each site to use in directing future planting work along most efficient lines. Cost was about 3 cents per acre, less than one-fourth of that previously experienced. Description of the method, which was presented at the national meeting of the Society of American Foresters, has been accepted for publication in the Journal of Forestry.

Under the third main division of the forest soils program--the study of the effects of forest management practices on soil--the effect of slash burning upon Douglas-fir forest soils was further investigated on paired plots established in 1948 by Fire Research. Changes in soil reaction and organic matter content after burning are being determined.

Additional forest soils assistance was given several of the national forests in the region. All the forests need soils maps of areas being intensively managed to give due consideration to soil management in

logging and other land management plans. As more forest soils information is developed, a definite program of extension of knowledge from research to the field is going to be required. This need should be provided for now in administrative planning.

The job ahead is a big one. Full-time study of forest soils in the Pacific Northwest started only three years ago. There is little background of previous research. The problem of site classification by soil characteristics has progressed well but much localized study will be required before we can evaluate accurately the productive capacity of the various forest lands in the region.

The study of soil problems related to regeneration assumes more importance than ever in the light of increased reforestation activities. Next year's studies in the pine region will include tests of some of the newly developed root growth stimulating hormones and the experimental use of wood chip or coarse sawdust mulches about planted seedlings. Little work on the soils phase of Douglas-fir regeneration has been done under the soils research program, and much is needed. Next efforts will be to further improve the techniques and extend the use of preplanting soil-site surveys and to study the soil-site-species relationships in southwestern Oregon. Study of slash burning effects upon Douglas-fir soils has been delayed by lack of soil laboratory facilities. A well-equipped soils laboratory is urgently needed.

The establishment of the Siskiyou-Cascade Research Center in southwestern Oregon opens up an area of study in which forest soils are probably more of a limiting factor than in any other part of this region. The relatively low precipitation and a complex geological pattern combine to produce critical soil management problems. An example is found on the rather extensive serpentine soils which, because of nutrient deficiencies, a sometimes toxic concentration of magnesium, and a characteristically shallow development, support a scrubby, low vigor forest. Damage from fires and logging is high here. Because of the soil structure, erosion and compaction from logging are severe.

A study of Port Orford cedar plantations and the soils on which they grow was started this year. The success or failure of these plantations, some of which lie outside the natural range of this species, are being related to soils conditions.

Additional demand for soils knowledge came this year with the establishment of a Flood Control Survey unit in the station. This accentuates the need for knowledge of infiltration and other soils characteristics that determine moisture storage capacity and erosion.

The job ahead is described by Tarrant in "A Program of Forest Soils Research for the Pacific Northwest" published in Northwest Science during the year. The listed but unsolved problems are many. Progress in forest soils research is being made, but efforts must be redoubled

if landowners are to learn the techniques of managing the soils they have and to improve them as the basis for all future production.

Forest Mensuration

Activity in the preparation of management plans declined temporarily during 1949 but again accelerated toward the end of the year. Results of forest mensuration research being put into everyday use were in demand beyond our capacity to supply. Operating without benefit of a mensuration project leader, progress was made on some studies through the employment for the third successive summer of Professor George Barnes of Oregon State College, through cooperation with the British Columbia Forest Service, the Oregon State Forester, the firm of Mason, Bruce & Girard, and several private forest owners. Also, Floyd Johnson of the Forest Survey staff worked part time on mensuration studies. Though largely incidental to other work, the Forest Management staff at the field centers contributed significantly to the combined accomplishments.

Barnes made excellent progress in the preparation of the western hemlock yield table. The new hemlock site classification was issued as Research Note No. 50. A preliminary draft of the new yield table was completed. Indicated western hemlock yields for average site III are given below and compared with the corresponding figures from the spruce-hemlock tables:

Comparison of Yield and Mean Annual Increment Per Acre for Site III Lands as Indicated by Spruce-Hemlock (1937) Yield Tables and by the New Western Hemlock Yield Tables

Age	Yield per acre		Mean annual increment per acre	
	Spruce-hemlock	Western hemlock	Spruce-hemlock	Western hemlock
Years	M bd. ft. Scrib.	M bd. ft. Scrib.	Bd. ft. Scrib.	Bd. ft. Scrib.
40	7	11	175	275
60	44	58	734	965
80	78	82	975	1,025
100	104	99	1,040	990
120	124	111	1,032	925
140	141	120	1,006	858
160	156	127	975	795
180	168	133	933	739
200	178	137	890	685

Yields shown by the new tables exceed those given in the 1937 spruce-hemlock bulletin for ages of less than 100 years but fall considerably below at greater ages. This is in agreement with existing hypotheses on hemlock growth trends. Barnes' work indicates that separate tables are needed to express well the yields of hemlock in Alaska and British Columbia. It is planned to complete this study next year and

present the manuscript for publication as a U.S.D.A. technical bulletin.

The Douglas-fir yield bulletin, U.S.D.A. Technical Bulletin 201, was revised and reprinted during the year and this best-seller is again available in quantity. The revised edition includes new tables based on current standards of measurement and a supplemental treatment showing yields by the easily measured variables of number of trees per acre, tree diameter, and height.

Routine, periodic 5-year examinations for mortality were made during the year on four permanent sample plots maintained in cooperation with Crown Zellerbach Corporation. Similar examinations were made for four such plots in the Douglas-fir plantings at Hebo. The station also cooperated with Weyerhaeuser Timber Company and the Forest Insect Laboratory in an extensive study of Douglas-fir growth and mortality in the Coos Bay area. At Voight Creek, intensive study of Douglas-fir growth rates by individual tree class and the response to various degrees of release was initiated using micrometer dial gauge dendrometer methods.

A new set of taper tables for western hemlock was completed during the year in cooperation with the Oregon State Board of Forestry and distributed as Research Note No. 51. They facilitate greatly quality cruising for this species. A new cordwood volume table for second-growth Douglas-fir was constructed and distributed as Research Note No. 52. A new set of regional volume tables for red alder was completed during the year—a product of cooperation with the Oregon State Board of Forestry, Weyerhaeuser Timber Company, and the British Columbia Forest Service. The series, which includes tables showing volumes in cubic feet and in board feet, by Scribner and International 1/4-inch rule and also by log position, was issued as Research Note No. 55. The job of adjusting second-growth Douglas-fir, Sitka spruce, and western hemlock volume tables to local utilization practices—scaling by 32-foot logs to 8-inch top—was virtually completed by the Willamette Research Center. Coordination with existing tables is the next step.

Study of the possibilities of saving time in the timber sale job through making sales by tree measurement was initiated on the applied forest management cuttings in Douglas-fir second-growth at Fall Creek and in spruce-hemlock at Cascade Head. The results will be issued during the coming months.

A methods-of-cruising study was conducted during the year with the Region 6 Office of Timber Management, the Forest Survey, the Willamette National Forest, Forest Management Research, and the Willamette Research Center cooperating. The objective was to find ways of short-cutting the cruising job required for timber appraisal in Douglas-fir old-growth sales. Field tests of various sizes of circular, rectangular and strip samples were made at Blue River Experimental Forest. The results indicate that rectangular plots 1 chain by 3 chains were most efficient. They provided 70 percent more information per man-hour of cruising than

did the least efficient kinds of plot samplings. Conversely, equal accuracy can be obtained by expenditure of only about 60 percent of the man-hours required using the least efficient plot patterns tested. A report on this project will be issued in 1950.

In the ponderosa pine subregion remeasurements of extensive permanent plot series during the past three years have accumulated a tremendous fund of new basic data on pine growth. The job of analysis, which promises to yield significant improvements in predictions is progressing slowly owing to the lack of a mensuration project leader. Information on "Growth of Ponderosa Pine" available to date was summarized by Briegleb in a paper of this title, presented at the national meeting of the Society of American Foresters, and has been accepted for publication in the Journal of Forestry.

Yield studies in the complicated mixed conifer types of southwestern Oregon were initiated during the year. Preliminary results indicate that the Douglas-fir yield table applies fairly well in pure stands of this species and that the ponderosa pine table is acceptable for estimating second-growth yields of this species in this area. These findings are particularly significant, because no plots were taken from this area in the compilation of the original tables. But pure stands of either species are rare here. Mixtures are the rule and our future studies are being shaped to devise methods of predicting yields in the wide variations in composition that occur. Preliminary observations show separate areas where each of sugar pine, ponderosa pine, Douglas-fir, and white pine will probably outgrow the others.

Fire Studies

Fire research was significantly increased in 1949 with the addition of a trained forester-meteorologist, O. P. Cramer, and the aid of a part-time field assistant. To help plan fire research that will be most useful and to assign proper priorities to the numerous studies needed, a Forest Fire Research Advisory Committee was organized. At the first meeting, held in July, it was decided to review periodically the status and problems of forest fire control. The ten members were chosen not as representatives of specific agencies but as individuals experienced and skilled in the techniques and research requirements of forest fire control.

Effects of slash burning. Under what circumstances should slash from clear cutting be burned in western Oregon and western Washington and what burning methods should be used? Some forest managers believe all slash should be burned, some believe none should be burned, while a large number think the answer depends on the conditions on each cutting unit. Fire protection leaders agree that adequate tests of these effects throughout the wide range of climate, timber type, slash, soil, slope, aspect, seed supply, and severity of burn commonly found in forest harvesting west of the Cascade Range has highest priority for fire research.

Some effects of slash burning are known for certain circumstances, but for many others the effects can only be guessed. Meanwhile, 200,000 acres or more of slash per year are being treated without sufficient guiding facts.

Since 1946 numerous paired slash study plots have been selected. One of each pair was to be burned while the other exactly like it was to be left unburned. Sixty such pairs were selected in 1949. Accidental or incomplete burning has eliminated about half of the selections each year. On the remaining usable pairs a detailed record has been made of the severity of burning on the burned plot. The comparative hazard, rate of brush and weed growth, and rate of tree seedling establishment have been annually recorded on both plots. These records were made during 1949 for 26 pairs.

Poor seed crops near most of the plots so far have provided little information on rate of seedling establishment, but the good crop in the fall of 1949 should give much information in the next few years.

The records of severity of burning on plots burned soon after sufficient fall rains are showing that even though all of the slash may be blackened and the flashy fuels consumed, there is only a small percentage of area in which the entire depth of original forest duff is burned or the mineral soil is severely burned.

Records of the density and kind of tree seedlings, brush, and weed cover on a large number of burned and unburned, but unpaired, cut-over areas of various ages were made in the period 1927-32 as a part of a study of changes in fire hazard. The cover changes on these areas were analyzed and described this year in a paper entitled "Ecological Aspects of Logging-Slash Burning in Western Oregon and Western Washington" by Morris, given at the annual meeting of the Ecological Society. A few of the results follow: At the end of two years the low ground-cover canopy equaled 80 percent of the burned but only 60 percent of the unburned surface area. This difference continued until the cover densities on both kinds of tract began to decrease at about 15 years. Brush cover density, on the other hand, was greater on the unburned than on the burned tracts from the first to the tenth years, but was less on the unburned after that. Coniferous regeneration was slower in starting on the average burned tract than on the unburned, but the density increased at a faster rate and after 24 years exceeded that on the unburned by 25 percent.

Techniques of slash burning. After deciding that slash on a certain area should be burned and how deeply it should be burned, the burning crew must use fire management techniques that will produce the desired results. Although numerous good and bad practices for managing slash fires have been recognized and described, the results to be expected from many different sets of circumstances have not been carefully recorded. Thus, studies of slash burning techniques are a part of the research program in Douglas-fir slash disposal.

Slash fires were observed for eleven days this fall by the two fire research men. Complete weather and fuel moisture measurements, slash and topographic descriptions, record of setting procedure, fire behavior, and severity of burn were made. The slash fires of 1949 may be divided into two distinct groups, those in the last half of September and those from about October 15 through the first week in November.

In northwest Oregon and southern Washington Cascades, and in parts of the Oregon Coast Range, the season will be remembered for the early slash fires that jumped their lines and swept over large adjoining areas on September 25, 26, and 27. Where slash fires, recent cutovers and rural communities were intermingled, many buildings were threatened and some burned. Large areas of restocking land and some merchantable timber were burned. Case histories of slash fires set during late September are being assembled to learn under what circumstances fires were confined to the planned burning area and under what circumstances fires escaped. The results should give new ideas of good and bad slash burning practices and also illustrate convincingly the results of practices previously recognized as good and bad.

Preliminary study shows that from September 5 to 19 sufficient rain had fallen to moisten the duff under the timber and in the open in most of northwest Oregon and western Washington. Clearing weather began on the 20th and numerous slash fires were set about that time. Some flat areas were too wet to burn well, but fuels on southerly slopes were soon consumed. Most fires were easily managed until strong east winds occurred the evening of September 25. Smoldering fire was fanned into flames and spread on the ground or by wind-carried embers. The east wind continued strong and steady in some localities, while in others it was alternately strong and light until September 27. In most localities those responsible for the slash fires did not have sufficient warning of the wind to mop up or give extra protection. The fires escaped before the danger was known and then control was almost impossible until the wind decreased.

In the second slash burning period, from October 15 to November 6, weather was very good and many areas that had not been fired earlier were successfully burned with little or no spread beyond the intended area. By this time the duff was well soaked under the mature timber as well as in the cutover. After a few sunny days the flashy fuels and log surfaces were dry enough to ignite easily except on steep north slopes and along the edges shaded by standing timber. Periods of strong east winds occurred in the Columbia Gorge and some valleys of the Oregon Cascades the last of October and early November. Again a few fires spotted across their lines, spread under green timber, and required considerable control work even where seven inches or more of rain had fallen since August and where fires could not be forced to spread the previous day. These cases show that if fuels are dry enough to burn in a loose or scattered arrangement, even though they are difficult to ignite, strong winds will suddenly cause the same fires to spot ahead and spread rapidly in fuels that previously would not carry fire.

Fire danger rating. A large part of adequate forest fire control is to provide adequate lookouts, patrolmen, and firemen at the time they are needed. Thirteen years ago the Experiment Station and Regional Forester's office devised a fire danger rating system to aid in judging the number of men needed during the average season on one district as compared to another or during different parts of the season on the same district. The daily ratings were largely based on local weather measurements and showed the rising danger with successive dry days. This indicated when changes in the protection force were needed. Since then roads have extended to most lookouts and make it practicable to keep a man at the station or use him on other work according to the danger. Short work weeks and overtime pay now require frequent rotation of men at a lookout unless weather of low fire danger prevails and allows the man to leave the station at the end of his work week. The increased variety of forest work related to timber sales, recreational use, and road maintenance favors more shifting of men between fire control and other activities according to the danger.

These developments call for a danger rating method that will give a daily estimate of tomorrow's danger based on the expected weather. Last winter the station attempted to devise such a procedure. The idea is that fire-weather forecasts of the U. S. Weather Bureau, local weather measurements, and known local patterns of weather variation can be used today to estimate tomorrow's danger. New methods were developed, tested, and compared with the old. To describe the new procedures the Fire Danger Rating chapter of the Region 6 Fire Control Handbook was revised by Morris and the Regional Office of Fire Control. Detailed instructions for determining local weather patterns from past records were issued in a pamphlet "Methods for Estimating Future Burning Index from Fire-Weather Forecasts and Local Weather Observations" by Cramer. Parts of the new system were tried on most of the national forests last summer. Danger ratings by both the new and old systems were compared. The new showed higher accuracy, but local variation in wind caused by topography and surface heating is still a major obstacle. For this reason further studies of wind patterns are planned. At the same time, studies of more intensive use of fire-weather forecasts in fire danger rating will be continued in cooperation with the Weather Bureau.

Midsummer fuel moistures compared. Daily moisture content readings of fuel moisture indicator sticks located at about 30 low-elevation and 30 high-elevation stations on the national forests of Oregon and Washington have been compared each year since 1941 for the period July 16-August 31. The yearly average values show how all of the weather factors, such as rain, dew, clouds, sun, temperature, and relative humidity, combined to affect forest fire fuel dryness in such fuels as solid, dead, barkless limbwood about $\frac{1}{2}$-inch in diameter and the outer $\frac{1}{4}$-inch of solid barkless logs and snags. The six-week period does not include the entire fire season but represents the principal midseason period of danger. Existing records for spring and fall are too few to compare those months in different years. Such records are needed to describe the severity of weather during the whole fire season.

For the midseason period the fuel moisture indicator sticks on the national forests, except in one locality, were drier in 1949 than in 1948. In eastern Oregon they were drier than any year except 1945. In most of western Oregon they were not as dry as in two or more other years. In Washington they were more moist than in all except one or two years since 1941.

Pine snag hazard persistent. "How Long Do Ponderosa Pine Snags Stand?" is the title of Research Note No. 57 by Dahms, issued during the year. There has long been general agreement on the serious fire hazard of ponderosa pine snags. This recent release shows that such hazard may be of long duration. On the study plot at Pringle Falls, more than 22 percent of the snags resulting from an old burn were found still standing 22 years after the fire. Fire control administrators are re-examining hazard reduction plans for pine cutovers in the light of this new information.

Plans for next year. During 1950 fire research will be mostly devoted to slash hazard and burning west of the Cascades and to fire danger measurement and rating. Fire behavior and rate-of-spread predictions are the base for all fire control work including the plans, prevention, detection, and suppression. Adequate means of making reliable predictions of fire spread are lacking. Present rough estimates are based almost entirely on the limited and variable experience of the individual dispatcher or fire chief. Actual rate-of-spread measurements should be made on many more wild fires and on test fires in selected fuels. Present resources do not allow this, but fire behavior and rate of spread will be studied to the limit of the resources available whenever wild fires occur that can be quickly reached. Records of past fires will be analyzed in search of behavior patterns.

Detailed knowledge of the management, effects, and use of fire east of the Cascade Range as a treatment for forest land too densely stocked or brushy is urgently needed, but there are presently no funds for such a study.

FLOOD CONTROL SURVEYS

A Division of Flood Control Surveys was organized in the station in October. Working with survey groups from the Northern Rocky Mountain, Intermountain, and California Stations, and from the Soil Conservation Service in Portland, the new division is to complete a flood-control survey and write a report with recommendations for the entire Columbia River Basin. This flood-control report will be designed for inclusion with the Department of Agriculture comprehensive plan for the Columbia Basin.

Objectives of the survey are: (1) to determine where and how often damages due to floods, erosion, and sedimentation occur; (2) to

locate flood and sediment source areas and to outline their causes; (3) to develop a program of land management and improvement that will reduce stream flow peaks, flood severity, and sediment production; and (4) to compare the costs of possible programs of improvement and management with the benefits deriving from reductions in floods and sedimentation. Information on damaged areas and on the type and extent of damages will be obtained in part from studies made by other agencies, such as the Corps of Engineers, in part from detailed field study by the survey. Climatic and hydrologic data are available in the published records of the Weather Bureau and the Geological Survey, and will be used to determine storm characteristics and their relation to flood occurrence. Conditions of the vegetation cover, soils, topography, etc., will be studied by means of Forest Survey or other available maps and compilations, aerial photographs, general reconnaissance, and detailed observations on specific sample areas. Land treatment or management program effects will be studied in much the same way. Recommendations for changes in management aimed at retarding runoff and at reducing flood and sedimentation damages, and for supplementary engineering structures where necessary, will be developed from studies on sample areas and expanded to the whole basin. In building up the program, the aim shall be to include only practices and measures that return benefits in excess of costs.

Personnel brought in for the new division include H. G. Wilm, transferred from the Southern Station; W. K. Nelson, from the R-6 Regional Office; W. E. Bullard and M. P. Twerdal, from the Division of Forest Management Research; and C. E. Hale and R. S. Sartz, from the Northeastern Station flood-control survey. Nelson will work on hydrology and engineering structures, Bullard and Hale on advance studies, Sartz on land use, Twerdal on maps and photogrammetry. Other technicians are to be added to the staff later.

The survey groups involved in the Columbia Basin survey met in Seattle early in October with Washington office representatives; flood-control policies were discussed, and work areas assigned to the various groups. In general, the PNW crew will cover the area west of the Columbia River in the State of Washington; drainages in the Puget Sound Basin and on the Olympic Peninsula; and the area of the Grande Ronde and adjacent drainages in eastern Oregon. They will be assisted by the Intermountain Station in surveying the interior drainages of southern Oregon. The PNW group will also be responsible for coordinating the activities of all the survey sections toward an integrated over-all survey report.

Hydrologists and engineers from the several stations met late in November to correlate techniques for attack on hydrology and engineering problems. An outline of proposed methods is being prepared; and a final outline of procedures will be established by February 1950.

Some field studies have already been started. A series of frost plots is being laid out along the Mt. Hood highway, on the Trout Creek

Hill experimental cutting at Wind River Experimental Forest, and along the Snoqualmie Pass highway in Washington. These plots will provide data on frost occurrence under different forest cover types and stand densities, and for different logging treatments. Such data are needed for determining effects of type and treatment on the disposition of snow-melt water. The study will cover variations from the lower west-side Douglas-fir to the east-side ponderosa pine and sagebrush.

On the Blue River Experimental Forest in west-central Oregon, three tributary watersheds of about half a square mile area each have been selected for study of the effects of timber cutting on stream flow. All three are in the Douglas-fir timber type, and support commercial stands. One watershed will be held as a check; after a suitable calibration period, one will be logged about 25 percent by small staggered-setting clearcuts, and the third will be logged about 80 percent by a large clearcut. Stream gages will be installed as soon as possible to begin the study. Meanwhile the recently installed gage on Lookout Creek, which has the entire experimental forest for its watershed, will furnish data of use to a study of the effects of logging and road construction on watershed conditions and water supply.

In the Green River watershed in west-central Washington (from which the City of Tacoma draws its municipal water supply) several tributary drainages have been gaged by the U. S. Geological Survey. This station is cooperating in a study on these watersheds to determine effects of cover type and land treatment on water supply. These smaller watersheds range in size from 2 to 15 square miles. Some are covered with young growth, some with old-growth Douglas-fir; some have been logged; some have been burned. This station's share in the study includes preparation of maps from aerial photos, delineation of cover types, and determination of soil and rock types.

These investigations will furnish data of value in working out hydrologic problems of the Columbia River survey. In addition, a start has been made on collection of stream flow, precipitation, and other hydrologic data; on compiling land-use and crop information; and on mapping out the physical complexes of soils, cover, etc., by which sample areas will be established for hydrologic study.

FOREST INSECT INVESTIGATIONS

(Bureau of Entomology & Plant Quarantine
in cooperation with Forest Service)

The year 1949 marked the twentieth anniversary of the establishment of the Forest Insect Laboratory in Portland. During the entire period of its existence, the laboratory has been closely associated with the Pacific Northwest Forest and Range Experiment Station. Out of this association and the resulting close cooperation, much progress has been made in developing methods for protecting the forests of Oregon and Washington against depletion by insects.

Research on forest insects in the Pacific Northwest was initiated in a limited way almost exactly 50 years ago. The first control work was conducted in 1910 against the mountain pine beetle in the Blue Mountains. Pine beetle surveys were begun in 1911 in the Klamath Basin and have since been expanded until they cover the entire forested area of Oregon and Washington.

Research on a comprehensive scale was begun in 1910 with the establishment of the Field Station at Ashland, Oregon. At first the main emphasis was on direct control of pine beetles. Some ten years ago the emphasis was shifted to indirect control through the recognition and removal of insect-susceptible trees, particularly in ponderosa pine forests. In the past five years the emphasis has again been shifted, this time to the control of coniferous defoliators and the bark beetle enemies of fir forests. Considerable progress has been made in all three of these general fields of study.

The appropriation of funds in 1949 under the Forest Pest Act permitted a materially expanded program. Survey and control activities were set up on an independently financed basis and the laboratory staff was enlarged. Spruce budworm surveys, control, and research, as was the case in 1948, continued to be the major activities. These activities, and other important projects carried on in 1949, are briefly discussed under the following headings:

Spruce Budworm Control

During May and June of 1949 some 267,000 acres of Douglas-fir forest heavily infested with the spruce budworm were sprayed with DDT from airplanes in a twofold project administered by the Forest Service and the Oregon State Board of Forestry. Technical supervision of the control work and the checking of results were handled by the staff of the Forest Insect Laboratory. An average kill of 97 to 98 percent of the budworm was obtained at a cost of approximately $1.15 per acre. The outstanding success on this project provided the basis for recommending an expanded program for control of the budworm in 1950.

Although the principal emphasis in 1949 was on the practical aspects of control, considerable progress was made in basic research. Detailed studies of the kinds of parasites and the degree of parasitism of the budworm were made in the Blue Mountains of Oregon. Two species of parasites were reared in numbers and colonized in the Northeastern States as the first step in an exchange of parasites between the East and the West. Studies of the biology of the budworm were extended, particularly in the working out of local development patterns as a guide in timing control operations. A 3,000-acre experimental aerial spraying project was conducted near Enterprise, Oregon, to determine the effectiveness of spraying during the summer months in an attempt to extend the spraying season. Results of this experiment will be evaluated in the spring of 1950.

Much additional information is needed regarding the spruce budworm in the Pacific Northwest. Efforts in 1950 will be directed toward (1) improving direct control techniques, (2) determining the effects of budworm outbreaks upon the defoliated stands, (3) evaluating the factors that influence the rise and fall of outbreaks, and (4) determining in more detail the habits and distribution of the budworm.

Forest Insect Survey

The annual forest insect survey provides two basic types of information: (1) data on the location, extent, and nature of insect outbreaks; and (2) timber loss statistics. The former are of use in planning control operations and in conducting biological studies. The latter are largely of value in guiding forest management practices to minimize losses caused by insects. In 1949, for the first time, practically the entire forested area of Oregon and Washington was covered, so far as the detection of insect outbreaks was concerned. Loss statistics were gathered principally in ponderosa pine stands and on limited areas of Douglas-fir in southwestern Oregon.

Aerial sketch mapping came into general use for the detection phases of the survey in 1949. This program was greatly facilitated late in the season through the acquisition of a 5-place airplane of modern design and high performance. A total of 210 hours were flown, of which 172 hours were occupied with actual mapping. The aerial survey was supplemented by extensive ground checking which was participated in by more than 100 cooperators. Long-term plots in the ponderosa pine region, both in virgin and cut-over stands, were continued.

The survey revealed 2,800,000 acres of epidemic infestation on the 49,000,000 acres covered. By far the largest outbreak was the 2,267,000-acre infestation by the spruce budworm. The acreages of other important outbreaks were: Douglas-fir beetle, 200,000; fir engraver beetles, 127,000; larch budworm, 86,000; and the mountain pine beetle, 76,000. Very little is known about the habits or destructiveness of the larch budworm which is epidemic in northern Washington. The mountain pine beetle outbreak in the Deschutes Basin is a direct threat to all

the mature lodgepole in that area. Losses in ponderosa pine caused by the western pine beetle are at low ebb.

Experiments in improving the mortality evaluation phases of the survey are continuing. Investigations of aerial photographic and aerial estimating techniques, to be undertaken cooperatively by the Experiment Station and other agencies, are scheduled for the spring and early summer of 1950. These investigations will involve both pine and fir forests.

Pine Beetle Hazard Zonation

The development of risk-rating procedures in ponderosa pine has made it possible to evaluate stands according to their relative risk of sustaining losses caused by insects. This procedure of evaluating risk has been termed "pine beetle hazard zonation." It provides the forest manager with information on which stands should be cut first to reduce losses caused by pine beetles.

Pine beetle hazard zonation was begun in Oregon in 1939 in the Klamath Basin and on the Deschutes National Forest. Since then the Sisters area of the Deschutes has been re-zoned and hazard surveys have been made on the Ochoco and Umatilla National Forests and the Warm Springs Indian Reservation. In 1949 the pine stands of the Yakima Indian Reservation were zoned according to pine beetle hazard. This program of hazard zonation has led to extensive changes in cutting priorities and has netted large savings of timber that otherwise would have been lost to the beetles.

Fir Engraver Beetle Investigations

A cooperative study undertaken in cooperation with the University of Washington, the Forest Service, and timber owners was initiated in 1949 to determine means of reducing losses in silver fir attributed to fir engraver beetles. The regional forest insect survey revealed over 100 centers of epidemic infestation of fir engraver beetles on a total of 127,000 acres, mostly in northern Washington. The studies undertaken in 1949 were largely to evaluate the problem and to make a start on determining the habits of the insects, the characteristics of their attacks, and the factors contributing to the outbreak. These studies will be expanded in 1950 with the emphasis on means of reducing losses.

Douglas-Fir Beetle Investigations

Losses caused by the Douglas-fir beetle continue to be an important factor in the management of Douglas-fir stands of Oregon and Washington. The Douglas-fir beetle problem in southwestern Oregon, particularly in Coos County, is under intensive study in a study carried on cooperatively with the Pacific Northwest Forest and Range Experiment Station and Weyerhaeuser Timber Company. Additional growth and mortality plots were established in 1949 and the annual reinventory of existing plots was made. The investigation of aerial methods of evaluating losses in Douglas-fir stands will be initiated in 1950.

PUBLICATIONS

Departmental Publications

Hayes, G. L. Forest fire danger. U. S. Dept. Agric. Yearbook 1949: 493-498.

Isaac, L. A., and Bullard, W. E. The Wind River Experimental Forest. U. S. Dept. Agric. Yearbook 1949: 169-172.

McArdle, R. E., Meyer, W. H., and Bruce, Donald. The yield of Douglas fir in the Pacific Northwest. U. S. Dept. Agric. Tech. Bul. 201, 74 pp. illus. Revised Oct. 1949.

Pechanec, J. F., and Stewart, George. Grazing spring-fall sheep ranges of southern Idaho. U. S. Dept. Agric. Circ. 808, 34 pp. illus. May 1949.

Outside Publications

Aufderheide, Robert. Getting forestry into the logging plan. Timberman 50 (5): 53-56, 96. March 1949.

_____ and Morris, W. G. Broadcast slash burning after a rain. Fire Control Notes 10 (4): 1-6. Oct. 1949.

Briegleb, P. A. Applied forest management in the Douglas fir region. Forestry Chron. 25 (3): 173-180. Sept. 1949. British Columbia Lumberman 33 (11): 76, 78, 80, 132. Nov. 1949

_____ Objectives and activities of the Douglas-fir Second-Growth Management Committee. Western Forestry and Conserv. Assoc. Proc. (1948) 39: 12-13. 1949.

Bullard, W. E. Relationship of mountain watershed conditions to Columbia River floods. In Columbia River Basin Water Forecast Committee, Transcript of meeting held at Portland, Oregon, April 12, 1949. pp. 11-15. Mimeo.

_____ Natural vegetation in the Willamette Valley. Science 110: 717. Dec. 30, 1949.

Garrison, G. A. Uses and modifications for the "moosehorn" crown closure estimator. Jour. Forestry 47: 733-735. Sept. 1949.

Hall, J. A. Development of integrated forest utilization in the United States. Paper prepared for meeting of Committee on Wood Chemistry, FAO, Brussels, August 25-27, 1949.

Hall, J. A. Industrial food - no panacea. The Land 8 (3): 322-327. Autumn 1949.

_____ Our creek died. The Land 8 (1): 17-18. Spring 1949.

_____ Wood fibre - creatable resource of wide utility. Paper for United Nations Scientific Conf. on the Conservation and Utilization of Resources, July 1949. 14 pp., mimeo.

Hayes, G. L., and Kittredge, J. Comparative rain measurements and rain-gage performances on a steep slope adjacent to a pine stand. Amer. Geophysical Union Trans. 30 (2): 295-301. Apr. 1949.

Isaac, L. A. Better Douglas fir forests from better seed. Seattle, Wash., Univ. of Wash. Press, 1949. 64 pp. illus.

_____ Recent development in silvicultural practices in the Douglas-fir region. Jour. Forestry 47: 957-960. Dec. 1949.

Johnson, F. A. Sampling for estimates of timber volume on large areas. Timberman 50 (8): 68, 70, 72. June 1949.

_____ Statistical aspects of timber-volume sampling in the Pacific Northwest. Jour. Forestry 47: 292-295. Apr. 1949.

Knauss, A. C. Dry kiln problems of small mill men. Wood 4 (11): 23, 48. Nov. 1949.

_____ Types, costs and specifications of kilns for small operations. In Northwest Wood Products Clinic, Proc. 4th, 1949: 13-15.

Locke, E. G. Chemical utilization of "wood waste." In Forest Products Res. Soc., Virginia-Carolinas Sec. Meeting, Durham, N. C., Nov. 4, 1949, Utilization of wood waste, pp. F1-F4, processed. (Preprint)

_____ Patterns for integrated complete wood utilization. Timberman 50 (11): 44-47, 92-93. Sept. 1949.

_____ Using wood residues to manufacture feed. Chemurgic Digest 8:(4): 12-13. Apr. 1949.

_____ (joint author with C. C. Heritage). Utilization of sawmill refuse and bark. Paper for United Nations Scientific Conf. on the Conservation and Utilization of Resources, July 1949. 22 pp., mimeo.

Locke, E. G. Wood as an industrial fuel. Paper for Northwest Industrial Fuels Symposium, Portland, Oregon, April 22, 1949. 10 pp., mimeo.

Matson, E. E. Recent logging improvements in the Pacific Northwest region. In Improvements in Logging Techniques in the United States, by G. L. Drake and others. Paper for United Nations Scientific Conf. on the Conservation and Utilization of Resources, July 1949. pp. 21-29, mimeo. Also Lumberman 76 (10): 94-96. Oct. 1949.

Munger, T. T., and Kachin, Theodore. Multiple-spur climbers for high pruning. Jour. Forestry 47: 375-377. May 1949.

Pechanec, J. F. Forest Service research in seeding perennial grasses on range lands. In Oregon Seed Growers League, Proc. 8th annual meeting, Nov. 29, 30 and Dec. 1, 1948, Portland, Oregon. pp. 35-44.

_____ (joint author with J. P. Blaisdell) Effects of herbage removal at various dates on vigor of bluebunch wheatgrass and arrowleaf balsamroot. Ecology 30 (3): 298-305. July 1949.

_____ What's ahead for the range society? -- presidential address, annual meeting, 1949. Jour. Range Management 2: 39-42. Apr. 1949.

Shaw, E. W. Hidden dollars in the forest. Oregon Farmer 72 (21): 5, 18 and Washington Farmer 74 (21): 5, 18. Nov. 3, 1949.

_____ Northwest woods a hidden asset. Oregon Farmer 72 (24): 6 and Washington Farmer 74 (24): 6. Dec. 15, 1949.

Staebler, G. R. Predicting the volume and normality of reproduction stands of Douglas-fir. Jour. Forestry 47: 828-833. Oct. 1949.

Tarrant, R. F. Douglas-fir site quality and soil fertility. Jour. Forestry 47 (9): 716-720. Sept. 1949.

_____ A program of forest soils research for the Pacific Northwest. Northwest Science 23 (2): 64-71. May 1949.

Wilson, R. C. The relief displacement factor in forest area estimates by dot templets on aerial photographs. Photogram. Engin. 15 (2): 225-236. June 1949.

Worthington, N. P. Lumber grade recovery and milling costs from second growth Douglas fir of central western Washington. Timberman 50 (11): 58, 60, 62, 64, 66. Sept. 1949.

Multilithed Reports

Barnes, G. H. Site classification of even-aged stands of western hemlock. 7 pp. Feb. 4, 1949. (Research Note no. 50)

Briegleb, P. A. Methods of management and methods of regulation of cut in the national forests of the North Pacific Region. U. S. Forest Serv. Management Plan Conference, Hot Springs, Arkansas, March 28-April 8, 1949, no. 19B. 17 pp.

_____ The use of yield tables in predicting growth, mortality and yield. U. S. Forest Serv. Management Plan Conference, Hot Springs, Arkansas, March 28-April 8, 1949, no. 15. 20 pp.

Cramer, O. P. Comparison of 1949 summer forest fuel moisture in Oregon and Washington with other years. 3 pp. Nov. 29, 1949. (Research Note no. 58)

_____ Methods for estimating future burning index from fire-weather forecasts and local weather observations. 25 pp. June 1949.

Dahms, W. G. How long do ponderosa pine snags stand? 3 pp. Sept. 26, 1949. (Research Note no. 57)

Gjertson, J. O. Practical guides for seeding grass on skid roads, trails, and landings, following logging on east-side forests of Washington and Oregon. 5 pp. Jan. 20, 1949. (Research Note no. 49)

Hall, J. A. Forest products research in relation to soil and water conservation. 8 pp. 1949.

Isaac, L. A. Can we save the seed crop? 2 pp. Sept. 12, 1949. (Research Note no. 56)

Johnson, F. A., and Engstrom, Wilbur. Taper tables for western hemlock. 5 pp. March 1, 1949. (Research Note no. 51)

_____ Kallander, R. M., and Lauterbach, P. G. Volume tables for red alder. 10 pp. Aug. 15, 1949. (Research Note no. 55)

Moravets, F. L. Lumber production in Oregon and Washington, 1869-1948. 12 pp. Dec. 1949. (Forest Survey Report no. 100)

Mowat, E. L. Preliminary guides for the management of lodgepole pine in Oregon and Washington. 10 pp. Apr. 29, 1949. (Research Note no. 54)

Shaw, E. W. Minor forest products of the Pacific Northwest. 10 pp. Dec. 1949. (Research Note no. 59)

Staebler, G. R., and Shaw, E. W. Cordwood volume tables for second-growth Douglas-fir. 3 pp. March 10, 1949. (Research Note no. 52)

Stevenson, E. W. Results of preliminary tests of pelletized crested wheatgrass seed. 7 pp. Apr. 25, 1949. (Research Note no. 53)

Tarrant, R. F. A program of forest soils research for the Pacific Northwest. 8 pp. Dec. 1949. (Research Note no. 60)

U. S. Forest Serv., Pacific Northwest Forest and Range Expt. Sta. Annual report - 1948. 51 pp. March 1949.

_____ A guide to the Cascade Head Experimental Forest. 23 pp. 1949.

_____ and Pacific Northwest Region. Forest type classification for Pacific Northwest region. 15 pp. May 1949.

PERSONNEL

ADMINISTRATION

J. Alfred Hall	Director
Samuel E. Kistler	Administrative Officer
Daniel W. Richmond	Chief Clerk
Frances Elliott	Secretary
Erna J. Jeppesen	Librarian
Elsie Andrews	Library Assistant
Edgel C. Skinner	Statistical Clerk
Leah Wheeler	Clerk-Typist
Ruth B. Ufen (11 mo.)	Statistical Clerk
George I. Hall	Misc. Dup. Mach. Operator

FOREST ECONOMICS

Robert W. Cowlin	Forest Economist
Floyd A. Johnson	Forester (Mensuration)
A. Kathryn Flaherty	Draftsman
Emma G. Johnson	Clerk-Stenographer

Forest Survey Inventory

Richard C. Wilson	Forest Economist
Carl E. Mayer	Forester (Mensuration)
Walter R. Johnson	Forester (Mensuration)
Robert B. Pope	Forester (Mensuration)
Charles E. Tyler	Forester (Mensuration)

Temporary

Michel J. Knight	Forestry Aid (Research)
John A. Sandor	Forestry Aid (Research)

Forest Resource Analysis

Floyd L. Moravets	Forest Economist

FOREST UTILIZATION SERVICE

Edward G. Locke	Technologist
Archibald C. Knauss	Technologist
Vivian B. Heigh	Clerk-Stenographer

RANGE INVESTIGATIONS

Joseph F. Pechanec	Forest Ecologist
Robert S. Rummell	Range Conservationist (Research)
Christina M. McPhail	Clerk-Stenographer

Temporary

Russell D. Lloyd (3 mo.)	Forestry Aid (Research)

FLOOD CONTROL SURVEYS

Harold G. Wilm	Forester (Forest Influences)
LaVone F. Cable (10+ mo.)	Clerk-Stenographer
Mary Lou Jamison (1 mo.)	Clerk-Typist

Advance Studies

William E. Bullard	Forester (For. Inf.)
Charles E. Hale (3 mo.)	Forester (For. Inf.)

Hydrology

William K. Nelson (1+ mo.)	Hydraulic Engineer

Land Use Classification

Richard S. Sartz (3 mo.)	Forester (For. Inf.)
Melvin P. Twerdal (5+ mo.)	Research Forester

FOREST MANAGEMENT RESEARCH

Philip A. Briegleb	Silviculturist
Robert F. Tarrant	Soil Scientist (Forestry)
Willard H. Carmean	Research Forester
Leona M. Bates (11 mo.)	Clerk-Stenographer
Ethel T. Arthur	Clerk-Stenographer
Elvera E. Hamm (4 mo.)	Clerk-Stenographer

Temporary

Frank J. Cassetta (4+ mo.)	Forestry Aid (Research)

Silviculture

Leo A. Isaac	Silviculturist

Applied Forest Management

Elmer E. Matson	Forester

Forest Protection

William G. Morris	Silviculturist
Owen P. Cramer (11 mo.)	Meteorologist

Temporary

W. Dale Heigh (3+ mo.)	Forestry Aid (Research)

Forest Management Research Experimental Forests

Pringle Falls Experimental Forest

James E. Sowder (10 mo.)	Forester (For. Mgmt.)
Edwin L. Mowat	Forester

Wind River Experimental Forest

Robert W. Steele (6 mo.)	Forester
William I. Stein	Forester

Temporary

Henry A. Houghton (3 mo.)	Forestry Aid (Research)

RESEARCH CENTERS

Puget Sound Research Center - Olympia, Wash.

Norman P. Worthington	Forester
George R. Staebler	Forester
Elmer W. Shaw	Forester
Ruth L. Kellum	Clerk-Stenographer

Temporary

Dale O. Frost (3 mo.)	Forestry Aid (Research)
Noel I. Olson (3 mo.)	Forestry Aid (Research)
Charles A. Schwab (3 mo.)	Forestry Aid (Research)

Willamette Research Center - Corvallis, Oreg.

Robert Aufderheide	Forester
Harold A. Rapraeger	Silviculturist
Roy R. Silen	Forester (For. Mgmt.)
Margaret E. Anderson	Clerk-Stenographer

Temporary

George H. Barnes (3 mo.)	Forester
Henry J. Gratkowski (3 mo.)	Forestry Aid (Research)

Cascade Head Experimental Forest - Otis, Oreg.

Robert H. Ruth	Forester

Temporary

David P. Wells (3 mo.)	Forestry Aid (Research)

Siskiyou-Cascade Research Center - Roseburg, Oreg.

G. Lloyd Hayes	Forester
Edward S. Kotok	Forester
Mary H. Winn	Clerk-Stenographer

Port Orford Cedar Experimental Forest - Powers, Oreg.

George A. James	Forester (Research)

Temporary

J. E. Wylie (3 mo.)	Forestry Aid (Research)

Blue Mountain Research Center - La Grande, Oreg.

Clark E. Holscher	Forester
George A. Garrison	Forest Ecologist
Ellerslie W. Stevenson	Forest Ecologist
Norma I. Nemeth (11 mo.)	Clerk-Stenographer
W. Joan Eales (1+ mo.)	Clerk-Stenographer

Temporary

DuWayne L. Goodwin (3 mo.)	Forestry Aid (Research)

John Day Experimental Forest - Unity, Oreg.

Walter G. Dahms	Forester

Starkey Experimental Forest and Range - La Grande, Oreg.

Robert W. Harris	Range Conservationist (Research)

Temporary

Roger M. Blouch (3 mo.)	Forestry Aid (Research)

COOPERATING AGENCY

FOREST INSECT INVESTIGATIONS

Robert L. Furniss	Entomologist
John M. Whiteside	Entomologist
William K. Coulter	Entomologist
John F. Wear	Pilot
Walter J. Buckhorn	Scientific Aid
Kenneth H. Wright	Scientific Aid
Olga M. Wulff	Clerk-Stenographer
Jacqueline Y. Ruggenberg	Clerk-Stenographer

Temporary

John H. Huber	Scientific Aid